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# ASTM BULLETIN

*Published by*
AMERICAN SOCIETY for
TESTING MATERIALS

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MAY—1940

No. 104

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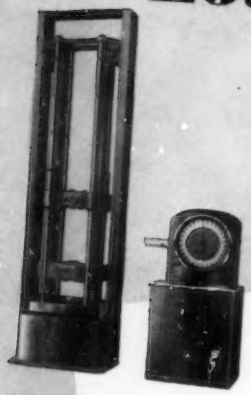

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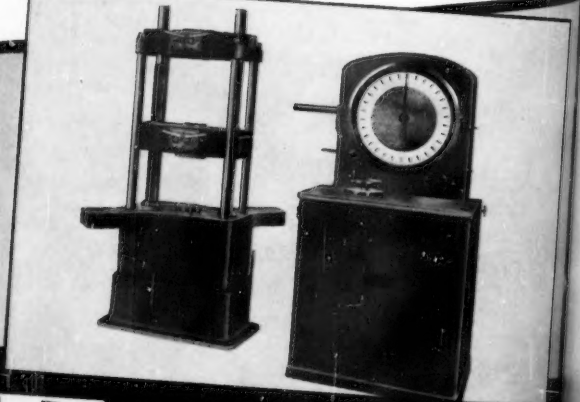

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# ASTM BULLETIN

*"Promotion of Knowledge of Materials of Engineering and Standardization of Specifications and Methods of Testing"*

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Number 104 May, 1940

# *Provisional Program for Forty-third Annual Meeting Indicates Many Interesting Sessions*

## Symposiums and Other Features to Mark Week of June 24 in Atlantic City

NOT ONLY are advance details provided in the Provisional Program published in this issue, for the Forty-third Annual Meeting of the Society to be held at Chalfonte-Haddon Hall, Atlantic City, throughout the week beginning June 24, but the program also gives synopses of most of the papers and reports to be presented. In so far as possible preprints of the papers and especially the reports will be prepared and forwarded to members on request in advance of the meeting. A Preprint Request Blank is being sent under separate cover to each member, simultaneously with the mailing of this BULLETIN.

Outstanding technical features include the Symposium on Tools of Analytical Chemistry, the first session of which is scheduled for Tuesday afternoon and the second for Wednesday morning, this feature being developed in cooperation with the Division of Physical and Inorganic Chemistry, American Chemical Society, under the leadership of G. Frederick Smith, Professor of Chemistry, University of Illinois, and Dr. G. E. F. Lundell, Chief, Chemistry Division, National Bureau of Standards. A number of outstanding authorities in the field of chemistry and chemical engineering will present interesting discussion.

The Symposium on Spectrochemical Analysis, which ties in closely with the Analytical Chemistry Symposium, will comprise two sessions on Thursday morning and afternoon. T. A. Wright, Technical Director and Secretary, Lucius Pitkin, Inc., is acting for Committee E-2 on Spectrographic Analysis in developing this interesting feature which has been divided into two parts: the first, accuracy requirements *versus* reproducibility possibilities; second, presentation and interpretation of results. Prominent authorities will open each session following which there will be an open discussion period.

One complete session of the twenty-two which are scheduled throughout the week will be devoted to a Symposium on Problems in the Classification of Natural Waters Intended for Industrial Use. A statement on this symposium is given in a separate article in this BULLETIN.

Following the procedure in effect at recent annual meetings, all day Monday, June 24, is reserved for committee meetings. The first formal session on Tuesday morning includes certain administrative committee reports, report of the Executive Committee, address by President H. H. Morgan, award of honorary memberships, presentation of certificates to forty-year members, and the introduction of new officers. Sessions then follow in the afternoon and evening throughout the remaining days including the closing sessions on Friday afternoon. Detailed information on the various sessions and the days on which they will be held can be noted from the Provisional Program in this BULLETIN.

One of the features of the meeting is an address at the opening session, upon invitation of the Program Committee, by Lt.-Col. William C. Young, Planning Branch, Office of the Assistant Secretary of War, on the subject, "Materials Standards in Industrial Preparedness." Colonel Young will outline to us some of the essential features of Industrial Preparedness, which, as many of our members doubtless know, involves planning for the procurement of supplies and equipment in the event of emergency. The importance of materials and commodity standards in such an event is recognized and Colonel Young will discuss in particular this phase and the relationship thereto of the work of our Society.

Colonel Young has had an active career in the Army. He was appointed to the Military Academy from South Carolina in 1909. After service in field artillery with the rank of captain at the outbreak of war in 1917, he served in the Ordnance Department of the National Army during the World War. He is now Lieutenant-Colonel in the Ordnance Department, and for several years has been assigned to important duties in the Planning Branch. He is a graduate of the Army Industrial College (1936) and has received the Order of the Purple Heart.

The two joint sessions scheduled for Wednesday afternoon are arranged to close at 4 o'clock at which time the Fifteenth Edgar Marburg Lecture on "Portland Cement—Theories (Proved and Otherwise) and Specifications" will be presented by P. H. Bates (see separate statement on following pages) and the Fourteenth Award of the Charles B. Dudley Medal will be made to T. F. Willis and M. E.

De Reus, Research Engineer, and Junior Engineer, respectively, Bureau of Materials, Missouri State Highway Dept., Jefferson City, Mo., for their paper on "Thermal Volume Change and Elasticity of Aggregates and Their Effect on Concrete." In connection with awards for outstanding papers, the session on concrete scheduled for Thursday evening will be of particular interest since this year for the first time the Sanford E. Thompson Award will be made as set up by Committee C-9 on Concrete and Concrete Aggregates for the outstanding paper on concrete presented at the 1939 annual meeting. The purposes of this award are to stimulate research, encourage the presentation of results of investigations that extend the knowledge of concrete and concrete aggregates, and to recognize meritorious efforts.

### Symposium on Classifying Industrial Waters

The object of this symposium in which outstanding authorities will participate, is to secure the adoption of uniformity in reporting the water analysis, and to secure data from which specifications may be developed for use in expressing requirements of the corrosivity and deposit protection characteristics. These data may be secured by utilizing appropriate testing procedures or formulas that have been found to give a reasonable approximation of rates of corrosion and of deposit formation. Thus the symposium is directed toward standardization of acceptable testing procedures, and formulating the classifications of water for industrial uses.

The program for the symposium is as follows:

Introduction—F. N. Speller, Consulting Metallurgical Engineer, Pittsburgh, Pa.

Reporting the Results of Water Analysis—Robert C. Adams, Jr., U. S. Naval Engineering Experimental Station.

A Review of Data on the Relationship of Corrosivity of Water to Its Chemical Analysis—V. V. Kendall, National Tube Co.

Measuring the Scale-Forming and Corrosive Tendencies of Water by Short-Time Tests—Everett P. Partridge and G. B. Hatch, Hall Laboratories, Inc.

A Method of Measuring Corrosiveness—J. H. Walker, The Detroit Edison Co.

The classification of the corrosivity and the deposit-forming characteristics of natural water, intended for industrial use, in service conduits and containers, is desirable for examining critically testing procedure, existing formula, and their future developments. Such test procedure and formula may then be employed by:

(*a*) The water consultant or user that he may properly interpret water analyses and exercise judgment in prescribing chemical or thermal treatment.

(*b*) The plant designer in order that he may more correctly specify and select materials for water service and treatment apparatus.

The symposium has been developed by Committee D-19 on Water for Industrial Uses, headed by Max Hecht, Pittsburgh, Pa., with F. N. Speller, Vice-Chairman, and R. E. Hall, Secretary. It is scheduled for 8 p.m. Tuesday, June 25, at Haddon Hall. All chemical engineers, metallurgists, and individuals concerned with the various problems being covered are urged by the committee to be present and to participate in the discussion.

### Papers at Committee Meetings

A large number of the Society's committees will meet during the week of the annual meeting, the final program distributed at the meeting giving a complete list of meetings with room assignments. It is of interest to note that at several of these meetings a number of technical papers will be presented, rather than at the Society's formal sessions. Committee E-4 on Metallography plans to devote a considerable portion of its meeting to papers and also Committee E-7 on Radiographic Testing. This has been a recent practice of the radiographic group and the papers given have been of considerable interest in this field.

### Preprints Sent on Request

In a separate mailing there is being sent to each A.S.T.M member in good standing a Preprint Request Blank by which he can request a copy of any of the technical papers and reports preprinted in advance of the meeting. This blank should be returned promptly and should be carefully marked, with the signature and mailing address of the member clearly indicated. The Provisional Program will enable members to make a selection of the items desired. Preprints will be forwarded to the members, probably in three installments. *Members should note that preprints will not be sent unless requested.*

### Hotel Reservations, Advance Registration

It is desirable that all members should make their hotel reservations promptly and for this purpose a return blank addressed to the hotel management, Chalfonte-Haddon Hall, is being sent in a separate mailing. Rooms can be secured on either the American or European plan at the special rates listed on the return blank. Since Chalfonte and Haddon Hall each has its own dining room service, members who wish to dine together should secure accommodations in the same division of the hotel, particularly if they are registered on the American plan.

In order to expedite registration of members at the meetings, it is desirable to have as many registration details as possible taken care of in advance and it would be very helpful if members would fill out and mail promptly to A.S.T.M. Headquarters the advance registration card that is being sent.

### Registration Procedure

Members and visitors should register at the A.S.T.M. desk as promptly as possible after their arrival at the hotel.

### Children's Week at Atlantic City June 28–July 4

While for the past two years Children's Week at Atlantic City has occurred during the week of the A.S.T.M. annual meeting, the Atlantic City authorities have this year set Children's Week to run from Friday, June 28, through Thursday, July 4. Consequently, for the first four days of the A.S.T.M. annual meeting children will not be entitled without charge to the usual facilities which the hotels, amusement places, and other Atlantic City institutions have placed at their disposal.

Each member will receive his badge, a copy of the final program and preprints of any of the papers and reports desired. The customary members' registration fee of $1 will be in effect. Visitors will receive the badge and program, and may secure preprints for any two sessions of the meeting. The visitor's fee is $1, but if a complete set of preprints is desired they may be procured by the payment of $1 additional.

IMPORTANCE OF MAKING RAILROAD RESERVATIONS EARLY—WORLD'S FAIR

Since the Republican National Convention this year is being held (in Philadelphia) simultaneously with the A.S.T.M. meeting, members should be sure to make their railroad reservations sufficiently early. While there are no special convention rates in effect, it has been indicated that the railroads will be granting reduced rates to the World's Fair in New York City and many of the members can undoubtedly take advantage of stopover privileges at Atlantic City. Full details on these rates and any other special rates which may be in effect can be obtained from the local ticket offices.

In planning their trips members should be sure to consult the latest timetables since on some railroads new timetables go into effect around the first day of the annual meeting.

## P. H. Bates—Marburg Lecturer

### Portland Cement—Theories (Proved and Otherwise) and Specifications

P. H. BATES, Chief, Clay and Silicate Products Division, National Bureau of Standards, Washington, D. C., will deliver the Fifteenth Edgar Marburg Lecture at the Society's annual meeting in Atlantic City on Wednesday afternoon, June 26. Mr. Bates plans to cover in detail a number of interesting points in connection with a material on which he is an outstanding authority and in which field he has been active for a great many years.

In connection with the scope of his Lecture, Mr. Bates has submitted the following statement:

"The theme of the Marburg Lecture this year will be largely given over to portland cement specifications. While the basis and significance of the proposed tentative standard for five types of cement will occupy most of the time, there will be discussed briefly our knowledge of what this commodity is and to a lesser degree how it reacts in contact with water. Since at the present time much attention is paid to basic research, the effect of admixtures as aids in production and for durability, new not generally accepted test methods, heats of reaction with water, etc., these will be reviewed in some detail.

"Portland cement is rather unique among the materials commonly used in construction. It is purchased in a dry form, mixed with a chemical reagent, water, and used in the form of a stiff to somewhat fluid paste. This latter shortly after being placed in service solidifies to a hard mass, which if the ideas of its ardent proponents are accepted, continues to change chemically—gains in strength—throughout its entire life. Thus, a material is purchased under specifications which are designed to assure us that it will react as expected under all the many conditions (favorable and unfavorable) existing in construction work and give the hoped-for result. Evidently such specifications are different from those for most other materials, and their preparation and requirements demand some unusual features.

"Research has shown that the amounts of certain compounds formed in the course of making cement can be estimated, provided a number of very critical observations have been made. These observations must be made with an accuracy that cannot be attained in commercially operating mills. Hence, recourse must be had to other means of estimating, and here the microscope and the X-ray have furnished much valuable information. However, no means are at hand which make it possible to estimate correctly the percentages of the compounds of known composition which could possibly be present nor the percentages of the compounds of unknown composition which are known to exist in the cement clinker. Estimates can be made of the compounds of known composition which may be present to a degree of approximation sufficiently satisfying to some to be used as a basis for acceptance specifications.

"The specifications which it is hoped will be accepted as tentative at the June meeting of the Society are an interesting compendium of requirements based upon what is is hoped a cement is—chemical and compound composition—and what it is hoped it will do—predictive physical tests. They do recognize the fact that the conditions of use and service are so wide that no one type of cement of one set of qualities can adequately meet all demands. They do not necessarily show that any one type could not meet all conditions; rather they convey the idea that a certain type may more adequately fulfill the demands of certain usages than another type.

"Historical evidence, laboratory research work and observations and data from the field are cited as providing justification for the acceptance of the proposed tentative specification for five types of cement. These citations are also presented so as to serve as a guide to a prospective purchaser to help him select the proper type for his immediate need. However, particularly this new standard through its evident and acknowledged lackings points definitely to the nature of and the direction in which intensive and immediate research must be carried out."

P. H. Bates

*Harris & Ewing*

After attending the public schools in Philadelphia, Mr. Bates entered the University of Pennsylvania from which he was graduated in 1902. For the next four years he was Assistant Chemist, Pennsylvania Railroad Co., and during the St. Louis Fair in 1904 was Chemist at the P.R.R. Locomotive Testing Plant. From 1907 to 1910 he was Chemist, Technologic Branch, U. S. Geological Survey, St. Louis, and then was in charge of the Pittsburgh Branch of the Bureau of Standards from 1910 to 1919. He became Chief of the Structural Miscellaneous Materials Division, at the Bureau, and Acting Chief of the Ceramic Division, 1919–1921, and since 1921 has been Chief of the Clay and Silicate Products Division.

A member of the Society since 1910, Mr. Bates has taken

a very active part in many committee activities, particularly those of C-1 on Cement. He has been chairman of this important committee since 1926, and previously served as secretary from 1916 to 1922. His other committee affiliations include Committees C-6 on Drain Tile, D-4 on Road and Paving Materials (he is chairman of Group B-14 on Specific Gravity of Fine and Coarse Aggregates), and C-15 on Manufactured Masonry Units. He is chairman of Subcommittee VII on Waterproofing and Protective Treatment of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete. From 1937 to 1939 he served the Society as a member of its Executive Committee.

He has been very active in the work of the American Concrete Institute and is a past-president of that organization. He is the author of a large number of papers and reports, many of his contributions appearing in the Society's *Proceedings;* one of his early papers in 1915 covers "The Effect of Finer Grinding and a Higher $SO_3$ Content Upon the Physical Properties of Portland Cement" and a later one in 1919 discusses "Cements Producing Quick-hardening Concrete."

Not only will all consumers and producers of cement be interested in what promises to be an outstanding lecture, but all other Society members concerned with the field of structural engineering in its many phases should find the lecture of interest.

The 1940 lecture will be the fifteenth in the series by outstanding technical authorities. Established in 1926 to emphasize the importance of the functions of A.S.T.M. in promoting knowledge of materials, it commemorates the name of the Society's first Secretary who placed its work on a firm foundation and through his development of the technical programs brought wide recognition to the Society as a forum for the discussion of properties and tests of engineering materials.

## Third Photographic Exhibit

EARLY IN May each member of the Society and representative of a company membership will receive an entry blank and a copy of the rules covering the Third A.S.T.M. Photographic Exhibit to be a feature of the 1940 Annual Meeting in Atlantic City. Previous exhibits have been highly interesting and entertaining and this year's should be no exception.

A committee of prominent photographers in the Philadelphia area is in charge of the exhibit headed by J. P. Mudd, The Midvale Co.

All members of the Society and those affiliated with company members are cordially invited to participate in the exhibit. It is hoped that a large number of prints will be submitted to the jury of selection.

While there has been recognition of the importance of well-chosen illustrations in connection with papers and reports—and a great majority of the illustrations have been good—the photographic exhibit directs attention to the many possibilities in this field. From the Society's standpoint the exhibit has much inherent value in directing attention to many phases of testing and research in the field of materials. A number of the photographs are used in the Society's BULLETIN and technical and business journals have asked permission to use them.

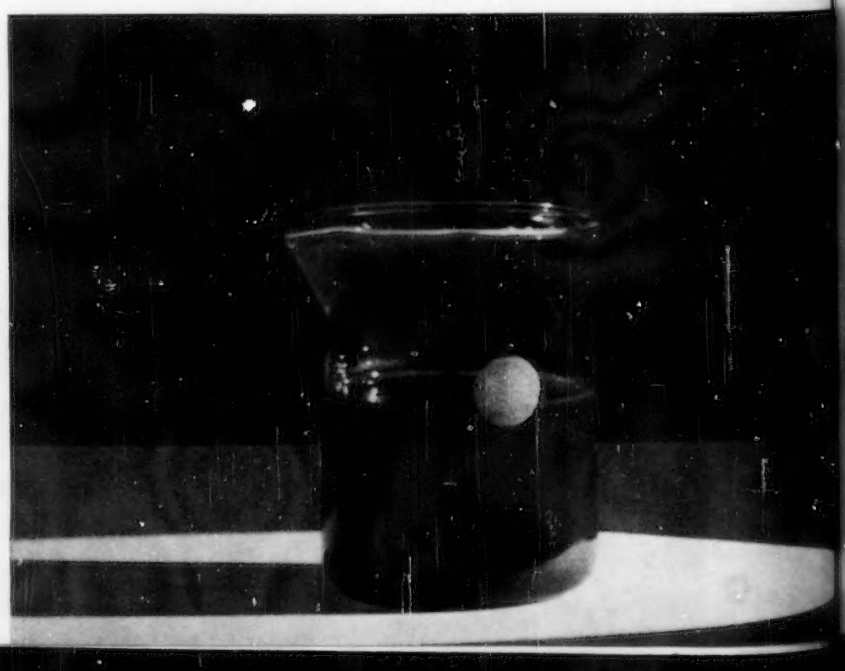
Copies of the entry blank and rules will be sent to any interested parties on request to A.S.T.M. Headquarters.

## Terminology on Grain Size of Steel

THERE HAS been intensive interest, particularly in connection with the use of materials for high-temperature service, in the grain size of steels, and because of the important position that grain size has taken in connection with creep and other high-temperature characteristics, the ASTM-ASME Joint Committee on Effect of Temperature on the Properties of Metals instituted some time ago as Project No. 20 the development of a summary on terminology of grain size. One of the important tasks was the development of a "primer" and in connection with this work J. R. Vilella, Research Laboratory, U. S. Steel Corp., developed a report on "The Grain Size of Steel" which was prepared for the Subcommittee on Grain Size (Project 20). This material was published in the April, 1940, issue of *Mechanical Engineering*.

This article is an attempt to state in the simplest possible terms the most important facts pertaining to the grain size of steel, and to point out the significance, if any, of several qualifying phrases, such as "McQuaid-Ehn grain size," "inherent grain size," "austenite grain size," and "ferrite grain size," these phrases being probably the main source of confusion to the lay reader. Its ultimate purpose is to assist any interested reader in understanding the matter as now seen by the metallurgist.

Reprints of the 15-page report are available and a copy will be sent without charge to members on request.



**"Miscible (?)"**

Awarded honorable mention, amateur class, in the 1939 A.S.T.M. Photographic Exhibit. Submitted by C. Ansel Downing, Engineer in Charge, Municipal Testing Laboratory, City of St Louis.

# *New Kind of A.S.T.M. Golf Tournament at 1940 Annual Meeting*

## *Will Run Throughout the Week; Daily Prizes*

A NEW KIND of A.S.T.M. Golf Tournament is being arranged by a special Golf Committee, the personnel of which is listed below. It is believed that a large number of A.S.T.M. golfers will be interested in the details of this plan and while a general outline follows, further details will be sent to the members before the 1940 Annual Meeting with an entry blank and other material.

In recent years the tournament has been scheduled usually on Thursday afternoon, and it has often been inconvenient, and sometimes impossible, for members to participate in view of conflict with committee meetings and annual meeting sessions, for increased pressure of technical activities has made it difficult to continue to reserve an afternoon for recreation that will be entirely free from Society sessions and committee meetings. Attendance and interest in the Golf Tournament have suffered to a considerable extent and the Executive Committee has accordingly approved an entirely new set-up.

Mr. M. Rea Paul, Director, Technical Paint and Color Service, National Lead Co., has taken the active lead in developing suggestions for the tournament and is serving as chairman of the committee which includes the following members:

1940 GOLF COMMITTEE

M. Rea Paul, *Chairman*, National Lead Co.
H. P. Bigler, Rail Steel Bar Assn.
J. G. Bragg, Alpha Portland Cement Co.
W. V. Brumbaugh, National Lime Assn.
A. V. Churchill, Aluminum Co. of America
G. H. Clamer, The Ajax Metal Co.
D. K. Crampton, Chase Brass and Copper Co., Inc.
V. A. Crosby, Climax Molybdenum Co.
M. P. Davis, Otis Elevator Co.
T. R. Galloway, Consolidated Edison Co. of New York, Inc.
W. M. Kinney, Portland Cement Assn.
C. M. Loeb, Jr., Climax Molybdenum Co.
W. B. Price, Scovill Manufacturing Co.
F. E. Richart, University of Illinois
J. McE. Sanderson, American Cyanamid Co.

*Time of Play.*—During the week of the annual meeting, tournament play will be held on Tuesday afternoon, Wednesday morning, Thursday afternoon, and Friday afternoon. The exception in the case of Wednesday is so as not to conflict with the Marburg Lecture which takes place in the afternoon.

*Place.*—Seaview Golf Club.

*Participation.*—Any A.S.T.M. member may play on any or every day that the tournament is held. The member must, however, pay his registration fee for each day that he plays and shall be entitled to the prizes that are offered on that day. Only personal members, official representatives of corporation members, and persons serving on committees, will be eligible to win regular membership prizes.

*Visitors.*—Visitors may play in the tournament, and if there are a sufficient number to justify it, special prizes may be made available for which they can compete.

*Championship Cup.*—The A.S.T.M. Trophy is awarded to the member turning in the lowest gross score. This year's competition for the trophy will be on the basis of the gross score turned in on the first day that the member registers for competition. The lowest gross score will be posted each day, on the A.S.T.M. Golf Bulletin Board.

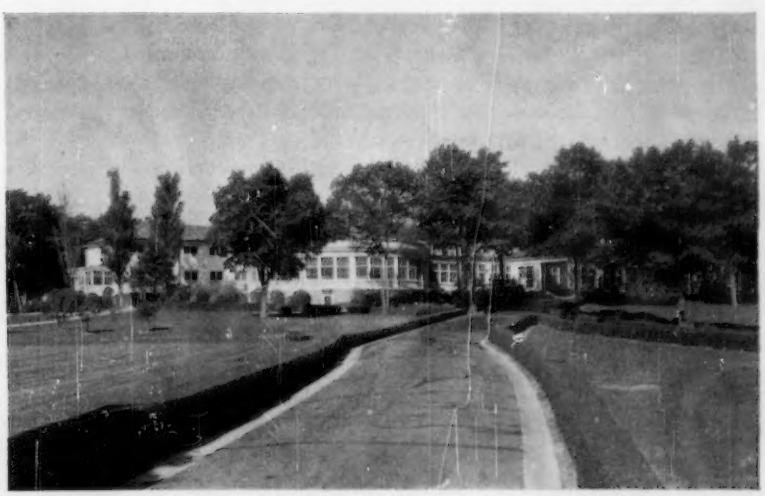
*Prizes.*—Daily prizes, to be decided upon by the committee, will be awarded at the conclusion of play each day at the clubhouse. They will be on the basis of kicker's handicap, ball nearest the pin on one short hole, and fewest number of strokes on previously selected blind holes. There will be no low net prize as in the past.

*Registration.*—A registration fee of $5 will be charged each individual, as in past tournaments; this fee is payable for each day played. To overcome any misunderstanding, and to aid in furthering the interest in the tournament, each golfer, on registering, will be furnished with a mimeographed notation of what the prizes are offered for, and certain local rules adopted for this tournament.

In order to relieve the tension at the first tee, and start some of the golfers off with a little higher morale, it is planned to allow each player to drive two balls and make his choice as to which he will play. This will apply to the first tee only. A ball coming to rest in a footprint in a trap, may be lifted without penalty and placed on the sand, no nearer the pin.

Certain other plans are being developed in connection with the tournament—the possibility of golfers' luncheons, etc.

Watch the Circular to Members, late in May, for further details!



Seaview Clubhouse

## Interesting New York District Meeting

A WELL-ATTENDED meeting, sponsored by the New York District Committee, was held in the main ballroom of the Hotel Pennsylvania, New York City, on April 4. Before the meeting about fifty members and guests met for dinner in the hotel. The arrangements for the meeting were under the direction of M. P. Davis of Otis Elevator Company, *Chairman*, and G. O. Hiers of National Lead Company, *Secretary*. Mr. F. M. Farmer of the Electrical Testing Laboratory, Past President of the Society, consented to preside at the meeting and, in addition to introducing the speakers, made a few instructive remarks on A.S.T.M. activities.

The original program included a talk on "Engineers of Tomorrow" by Dr. Albert Lloyd Colston, principal of Brooklyn Technical High School, and a paper "Testing for the Consumer" by Ephraim Freedman, Director of Macy's Bureau of Standards, R. H. Macy Co.

While both papers were delivered in a most interesting manner, Dr. Colston unfortunately was unable to attend due to very urgent city business. But he was ably represented by William Pabst, first alternate to the principal and chairman of the Department of Applied Electricity of the Brooklyn Technical High School. Mr. Pabst also is technical director of the Board of Education's broadcasting station WNYE.

In his talk he gave a brief history of American education and traced the growth of American schools from early days when the professions of law, research, and medicine were stressed, to the modern era where the need of industry for those trained in science and technology has become paramount.

A short history of the growth of the Brooklyn Technical High School illustrated the need for technical training both to students who cannot go to day college for advantageous entrance into industry in technical and semi-technical positions and to give a superior preparation to students planning to enter engineering colleges. Mr. Pabst stressed the fact that the Brooklyn Technical High School is not a trade school, but that it is the intention of the faculty to combine theory and practice and to create for the students, insofar as is possible, life situations in adult surroundings and to adult standards. The talk then continued with a proof of the accomplishments of the objectives which he had outlined and concluded with a description of the plant and equipment. Lantern slides supplemented the talk. These photographs were most enlightening to the audience and illustrated careful planning of the courses as well as the excellent equipment available to the students of these classes. It was evident from Mr. Pabst's talk that the A.S.T.M. methods and standards were made use of in many of the courses and were highly valued.

Mr. Freedman's talk, while on a different subject, proved equally instructive and interesting. Mr. Freedman is director of Macy's Bureau of Standards, R. H. Macy Co. He is a professional engineer and chemist, and a member of the A.S.T.M. He has many other connections with technical societies; is also chairman of the Standards Committee of the National Retail Dry Goods Assn.

Mr. Freedman pointed out that testing for the consumer requires an approach primarily different from that required by testing for the manufacturer in that the test methods in many cases simulate conditions of actual use. He gave as an example the testing of razor blades for degree of sharpness where it was found necessary to design an apparatus which would actually reproduce shaving conditions. The machine measures the force required to cut a human hair. Other examples included an artificial foot equipped with perspiration ducts and a rocker-like holder. By rocking the shoe and at the same time adding a perspiration solution the resistance to wear under actual walking conditions could be measured.

Mr. Freedman also mentioned the necessity for guarding against imperfect or dangerous materials, such as those which might become flammable or which, owing to the rapidity of their development, may be offered for sale before knowledge of their adaptability to serviceability has been acquired. Tests must be devised for detecting such defects before the product is offered to the public.

Chemical, physical, biological, and bacteriological tests are required for consumer testing. Among these, many A.S.T.M. methods were found to be of great value in testing for the consumer. Mr. Freedman concluded with the showing of many beautifully colored illustrations of equipment used in his laboratory which included a number of so-called A.S.T.M. testing instruments which are constantly in use.

## Southern California Members to Meet

THE SOUTHERN California District Committee under the chairmanship of John Disario, Columbia Steel Co., Torrance, Calif., and E. O. Slater, *Secretary*, Smith-Emery Co., Los Angeles, Calif., has completed plans for a dinner meeting of A.S.T.M. members and friends in the Los Angeles district to be held at the Riverside Drive Breakfast Club, 3213 Riverside Drive, Los Angeles, beginning at 6 p.m. on Friday, May 10.

Following the dinner, Dr. Rudolph M. Langer, Physicist, California Institute of Technology, will speak on the subject "The Use and Application of the Spectrograph for the Study of Minerals, Metals and Gases."

The concluding part of the meeting will be a lecture on "Around the World With the Sun" at the Griffith Park Planetarium.

All members of the Society, their associates, and friends are cordially invited to attend this meeting. It is suggested, those planning to attend should inform Mr. Slater in advance.

## President Morgan on Patents Committee

THE NATIONAL Committee in charge of the U. S. Patent Law Sesquicentennial and Selection of Twelve Outstanding Inventions includes the heads of a number of engineering and technical societies and President H. H. Morgan represents A.S.T.M. on this committee of which Mr. C. F. Kettering is chairman. Mr. Morgan attended the recent dinner celebration in Washington. In connection with the selection of the inventions the officers of the Society's standing committees have been asked for their opinions. The results of this survey have been referred by Mr. Morgan to Mr. Kettering for his assistance in connection with the selection.

# SYMPOSIUM ON PLASTICS

## Recent Advance in the Field of Laminated Plastics[1]

By E. R. Perry[2]

It has been said by many that the world is now on the threshold of a plastics age. If this is so, it is perfectly natural that there should be a lot of questions concerning the nature of plastics and the reasons for their rapidly increasing use in modern life. Like any new material, plastics have had and are having some difficulty with growing pains. By this is meant that there is a tendency to make everything from saxophones to locomotives with plastics. From the standpoint of publicity, sales promotion, and the development of new markets, this might be considered desirable. From the standpoint of continued good will and stability in the industry, it is dangerous. However, again, like all new things, plastics are slowly filling the applications where they are outstanding both from the standpoint of improvement over substituted materials and for opening up new commercial possibilities and outlets. Originally, these materials were evolved to fill a need for electrical insulating materials having higher mechanical strength than anything then available. As the industry grew, the natural sequence was the discovery that these materials had outstanding properties such as acid and chemical resistance, resistance to abrasion, high mechanical strength-weight ratios, and such properties which were unique and definitely in demand for other industries.

The term "plastics" is quite broad in its literal meaning since it covers, in addition to synthetic resins, materials such as shellac, rubber, porcelain, glass, natural gums and resins, and other things which have been known for many years. Recently, the synthetic organic portion of this classification has become so outstanding that the term has become more and more specific in its accepted meaning. There are two principal classes of synthetic resins. One is called thermoplastic, which by definition covers those plastics which will repeatedly soften at elevated temperatures. The other is called thermosetting, which covers those resins that will become infusible during an initial application of heat. Each class has its specific uses which require its individual differences in properties.

Plastics, as supplied in the trade, may be made up of one or more components. In all cases, there is a resin constituent which is not necessarily modified by further additions. In most cases, however, other materials are added either to accentuate specific properties, to maintain a certain price range, or to modify the average physical characteristics. For example, dyes or pigments may be added to show a particular color. Wood flour, cotton flock, asbestos fiber, paper, cloth, or wood may be incorporated to bring about certain physical qualities which the pure resin does not possess. Various types of clays or pulps may be combined in order to lower the ultimate cost when high quality products are not required. There is a specific technique for the use of each of these which is based on the requirements of the finished article. In general, resistance to chemicals, moisture, weathering, and such elements is exhibited principally by the resin. Characteristics of mechanical strength, such as impact, tensile, flexural, abrasion resistance, etc., are dependent on the filler. This latter point is generally true, but by no means as important in the horny type thermoplastic materials as it is in those more brittle materials classified as thermosetting.

Sheet stock for laminated material is prepared by passing a continuous roll of paper or cloth through a bath of resin solution and then through a dryer, which removes the solvents and converts the resin, chemically, into the proper state. The material derived from this operation is hard at room temperature and dry to the touch. It is, however, fusible at relatively low temperatures, which, of course, is necessary for the molding process. For finished articles which are relatively flat, the material is used in sheet form. If more intricate shapes are desired, this treated sheet is cut into small squares ranging from $1/16$ to $1/4$ in. and then handled in about the same manner as molding powder. An advantage of this form over standard molding composition is that liquid impregnation of the fiber is more complete and that the fibers in chopped sections are generally longer than those in the average molding powder. It has the further advantage that it is usually waste derived from cutting of treated material for special shapes.

Flat laminated stock and shapes made from chopped laminating materials are generally made by the compression molding process. Chopped mixtures require the same sort of molds as those used for composition. The molds for flat stock, instead of being machined to the complete contour of the sheet, consist of flat, chromium-plated steel plates, with the resin impregnated sheet stock incorporated as the filling in a sandwich between two plates.

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[1] Presented as part of a Symposium on Plastics held at a meeting sponsored by the A.S.T.M. Pittsburgh District Committee, January 29, 1940.

[2] Engineering Manager, Micarta Dept., Westinghouse Electric and Manufacturing Co., Trafford, Pa.

The material is molded at high pressures, say 1500 to 2000 psi., and at temperatures up to 180 C. The resin is converted to its infusible form in about a half hour per 1/16-in. section and is subsequently cooled to 100 C. or below while still under molding pressure. The finish of all molded parts is governed by the finish on the mold surface which is against the material in its plastic stage. In composition or thermoplastic molding, quite a wide variety of finishes is used. In flat laminated plate there are three principal finishes, namely, high gloss, semi-gloss, and satin.

In the popular field, laminated plastics are beginning to show prominence. They are now available in virtually any color in both the conventional and cigarette resistant forms. The materials are produced by the use of a resin impregnated filler stock with a surface sheet carrying either a printed pattern or a pigment color which is also resin impregnated. The components are compression molded into a semirigid plate, which is generally used as a veneer on a cheaper backing material. It is becoming quite popular for use in wall panelling, bar fronts and tops, table tops, elevator cab linings, murals, kitchen work surface, bathroom walls, or any place where a semi-permanent, warm material, having a completely prefabricated finish, permanent color, low density, and resistance to moisture and solvents, is desirable at a reasonable cost.

More recent in this class are materials having real wood as a facing sheet, and those having a flexible back. The former are available in any foreign or domestic woods used as architectural materials. The color may be either natural or stained. Solid colors, printed patterns, and wood are all available with the flexible back. The particular value of the latter lies in its ability to be veneered to a face having a 2-in. radius either convex or concave to the surface.

By far the largest number of applications for laminated stock are in the industrial field. Although a large portion of the output is for electrical insulation, there is quite a variety of new applications for other industries.

In the field of bearings, laminated plastics are used for roll neck bearings in steel mills, for bearings on ball and rod mills, on sugar mill rolls in the extraction of juices, for propeller shaft and pintel bushings in marine work, and for pump-shaft bearings in various oil and chemical handling pumps. Most of these applications require only water as a lubricant, and very good results have been obtained. In steel rolling mills the life of a plastic bearing is ten times that of bronze or babbitt where pressures up to 5000 psi. are encountered. In addition to the increased life, savings in power up to 30 per cent have been recorded due to lower frictional losses. For marine work, the material is a "natural" since its most desirable lubricant is available in any quantity.

Laminated safety helmets are used in a variety of industries requiring skull guards. Although quite light in weight, each helmet is required to stand an impact on the crown of 40 ft-lb. without crushing.

In the paper-making industry, laminated plastics find uses as table roll covers, suction box covers, doctor blades, toe blocks, shake springs, and a number of bearings. They are used here because of their resistance to chemical action and their marked ability to polish instead of scratch metal surfaces rubbing against them. Other chemical-resisting applications are linings for plating tanks and barrels and bubble caps for scrubbers, stills, etc.

In the textile industry, particularly rayon, where chemical resistance is important, laminated plastics are used for spinning buckets, washing drums, reels, washing spindles and pirns. Their primary value in this work is shown by resistance to 10 per cent sulfuric acid which is used throughout the process, and the fact that a trace of iron would cause staining of the rayon and subsequent spoilage for other steps in the process. Laminated shuttles and picker sticks are valuable for loom work because of their resistance to abrasion and high impact fatigue.

The lightweight and high strength-weight ratios of plastics make them quite interesting in the aircraft industry. Composition molded and cast plastics are used for instrument and control knobs, windows, and windshields. Laminated plastics are used for pulleys and fairleads in guiding cables from the cockpit controls to the ailerons, rudder, elevators, etc. Although these sound like insignificant items, they take on a measure of importance when it is known that between two hundred and five hundred are used on each transport plane. Recently an entire fuselage has been fabricated from plastic bonded plywood. Although the idea is revolutionary today, plastics will undoubtedly be a major factor in future aircraft construction.

A large quantity of laminated plastics has been consumed for a number of years in the fabrication of various types of gears. A train of gears in which laminated material works against metal has longer life and a considerably lower noise level than metal-to-metal combinations. The most popular of these has been in automotive timing gears, but large quantities also are used for everything from clock gears to large motor pinions. One particularly interesting application is a gear in a refrigerator compressor unit which, after running for five years in an atmosphere of freon (today's popular refrigerant), showed absolutely no deterioration.

Another important application for laminated plastics, part of which is quite recent, is for interior parts of refrigerator cabinets. It has been used for insulating breaker strips on the door and the door opening for many years. In this application it has been black in color and acted as a thermal insulator to break the metal-to-metal contact between the inner and outer shells of both the cabinet and the door. This year the material is being used as the entire door liner through which the thermal insulation is improved and the total weight of the door reduced. The panel in this case is produced in a color match with the porcelain cabinet interior.

Other numerous applications for laminated plastics include fan blades because of light weight and low noise level, asbestos shingle molds, electric stairway treads and rollers, radio parts, nameplates, etc.

The question of whether the plastics age is rapidly approaching is purely one of speculation and may be based on the desire of the industry. Nevertheless, there is no doubt that plastics are becoming more and more important in everyday life. It is hoped, therefore, that this survey may help, in some measure, to make more familiar the backstage antics in the evolution of these products.

# Plastics for the Engineer[1]

By R. L. Wakeman[2]

PLASTICS ARE employed in the fabrication of such a host of common objects that, despite the early use of "Bakelite" by the electrical industry, they are still associated in the minds of many with the idea of "gadgets." In some quarters this conception has lately undergone considerable modification so that we now find a good deal of over-enthusiastic journalism in which the pendulum has swung too far to the other extreme. It is becoming the style to speak of plastics as substitutes for natural materials, such as stone, wood, and metal. Both of these current, but incorrect, notions fail to appreciate the true significance of the role which plastics now play and which they are increasingly destined to play in the world's economy. There is obvious fallacy in the autarchical attempts of totalitarian regimes to develop, from relatively expensive synthetics, "Ersatz" for cheap natural products.

Plastics possess their own characteristic properties which are not to be found in the same combinations in nature. They are constructional and engineering materials in their own right. They are, of course, used in the manufacture of numerous small objects and knicknacks for which they are eminently suited because of their adaptability to mass production methods of molding and because of the style of their light and glossy molded shapes. In addition to such applications, however, plastics faithfully serve many branches of engineering, such as the building, illuminating, aeronautic, automotive, and electrical fields. Without them, the automobile, the airplane, the telephone, and the radio could not have attained their present high state of development. Many very important applications in these industries never come to the attention of the general public. To take but a single example, resinous condensation products of cashew oil (from the outer shell, strange to say) and formaldehyde have played a fundamental part in the development of high-quality brake linings. The remarkable characteristic of the plastics industry is the versatility of its products. It is this which has caught the imagination of the public as well as of the engineer and the manufacturer. The present flowering of the industry is due to this versatility and to the knowledge of high molecular weight chemistry which has been developed during the past two or three decades. With this knowledge, chemists and engineers are now able to synthesize resinous products having certain more or less predetermined chemical and physical properties and it is this synthesis which differentiates today's products from those of the industry's infancy.

### History of Plastics

The true foundation of the modern plastics industry was laid just a century ago last year, when Charles Goodyear discovered the process of vulcanizing rubber by chemically combining it with sulfur. Twelve years later, his younger brother, Nelson, produced ebonite, or hard rubber, a discovery which proved a tremendous boon to the infant telephone and telegraph industries.

A few years later, in 1868, John W. Hyatt, an American printer, experimented with nitrocellulose while seeking to win a prize offered for a material which could be used to manufacture inexpensive billiard balls. Nitrocellulose was already known. It had first been made by the French chemist, Pelouze, thirty years earlier. Hyatt, however, discovered that it was compatible with camphor and that the product, thus plasticized, could be molded into objects resembling ivory. Although his billiard balls were unsatisfactory, he thus discovered "Celluloid"!

Shortly after the turn of the century, the first purely synthetic resin was obtained by suitably controlling the reaction of phenol with formaldehyde. It was synthesized by Baekeland in his private laboratory in Yonkers, N. Y., and at about the same time by Redman, working at the University of Kansas in the organization which was later to become Mellon Institute. The interests which made these plastics available under the trade names "Bakelite" and "Redmanol" soon merged into the Bakelite Corp.

All these first three fundamental discoveries which established the plastics industry were made in the United States. The industry was American born and, although it is well developed today in all the major countries of the world, the American industry still leads.

### Classes of Plastics

Synthetic resins and plastics are complex organic compounds, usually mixtures of such compounds, which possess high molecular weight and which show no tendency to crystallize. For the engineer, it is important that they can be grouped, approximately, in three classes: namely, thermosetting, thermoplastic, and chemosetting. A thermosetting resin becomes plastic upon heating, can therefore be molded by suitable application of heat and pressure, but upon continued heating undergoes chemical reaction and solidifies while still hot to a hard mass which no longer softens below its decomposition point and which is usually insoluble in all ordinary solvents. "Bakelite," "Durez," and "Plaskon" are typical thermosetting resins. On the other hand, a thermoplastic resin, as the name implies, is one which upon heating becomes plastic, that is, it softens or perhaps melts, and remains in this softened or liquid state as long as it is held at an elevated temperature. Upon cooling it solidifies to its original condition and is permanently soluble in appropriate solvents. This process of softening by heat can be re-

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[1] Presented as part of a Symposium on Plastics held at a meeting sponsored by the A.S.T.M. Pittsburgh District Committee, Pittsburgh, Pa., January 29, 1940.

[2] Industrial Fellow of the Pittsburgh Equitable Meter Co 's Industrial Fellowship on Meter Technology at Mellon Institute of Industrial Research, Pittsburgh, Pa.

peated as often as desired in the case of any thermoplastic resin, such as "Tenite," "Lucite," or "Vinylite." A chemosetting resin is one which can be converted to an insoluble, more or less infusible form, by reaction with some other element or compound. Casein plastics and drying oil-modified Glyptals are typical of this class.

In addition to these three kinds of plastics, there is a fourth group which has certain characteristics of each: namely, the elastomers or rubber-like plastics.

It is essential to understand this classification in order to evaluate and select a suitable material for a given job.

### Thermosetting Resins

The most distinguishing characteristics of the thermosetting resins are heat and solvent resistance. They are fabricated by compression molding, transfer molding, laminating, or casting. The two important types of thermosetting resins on the market at present are the phenolics and the ureas. The latter are lighter in color than the former, but their resistance to water and water vapor is poorer. Recently, foreign manufacturers have begun production of a new type of transparent and brightly colored thermosetting resin which is a formaldehyde condensation product with the organic nitrogenous compound, melamine.

By suitable modification, both phenolic and urea resins can be produced in forms which fit them for lacquer use. An important application of modified urea resins is in the treating of textiles to render them crease-proof. Certain thermosetting resins produced from complex natural phenols and other products are being developed as water-softening agents, because of remarkable acid- and base-exchange properties recently found associated with them.

### Thermoplastics

Let us now turn to the thermoplastics, of which there are many different kinds. They are distinguished from the thermosetting resins in a number of their physical properties, among which behavior toward heat is the most important. They are less heat-resistant, although there is considerable variation in this property, depending upon the individual members of the group. The great number of thermoplastic resins is reflected in a correspondingly wide diversity of properties. There are five principal ways in which they are fabricated: namely,

1. Molded and extruded shapes
2. Sheet
3. Solutions
4. Filaments and threads
5. Miscellaneous products

Among the molded thermoplastics, cellulose esters, including the nitrate, acetate, acetopropionate, and acetobutyrate, are the most important. The acetate and acetobutyrate are widely used, for example, in automobile steering wheels and other interior parts of the modern car. Cellulose ethers are now also assuming importance.

Polyvinyl resins such as "Vinylite" and "Styron" are finding an expanding market in the production of extruded and molded articles. The dielectric properties of polystyrene are as good as those of fused quartz.

Among recent thermoplastics, the acrylates and methacrylates have rapidly gained popular recognition, largely because of their extreme clarity, which exceeds that of glass. They are well known under such trade names as "Plexiglas," "Crystalite," and "Lucite." The unique optical qualities of these plastics make it possible to "pipe" light around a corner. During the past year, this property has been utilized in the production of curved dental and surgical instruments made of "Lucite," which carry cool light to the required spot in a patient's mouth or throat.

The extraordinary clarity of the methacrylates adapts them to use in road reflectors, speed limit signs, and danger signals. Carefully designed "Stimsonite" retro-directive road reflectors accurately molded from "Lucite" have made an important contribution to the safety of the highways at night.

Several of the thermoplastics are employed in sheet form for various purposes. Safety glass is the outstanding application of this nature. The last few years have seen the birth and development of a new high-test interlayer for safety glass, a properly plasticized polyvinyl acetal. It possesses unusual toughness and imparts shatterproof characteristics to glass reinforced therewith, even at low temperatures.

Films from rubber hydrochloride, ethyl cellulose, and polystyrene are among recent developments.

Most of the thermoplastic resins are used in solution for many purposes. Nitrocellulose and alkyd resins are of vital importance in the modern lacquer industry. "Vinylite" has important uses in lacquered beer can linings, in impregnating solutions, and in adhesives. Polyvinyl acetal resins have come into commercial use in coating "Formex" magnet wire. In addition to the classes of resins already mentioned, chlorinated rubber and isomerized rubbers are bases of commercial concrete paints and other acid- and alkali-resistant coating materials. They are likewise important adhesives. Isomerized rubbers, particularly, have found extremely valuable engineering applications in bonding rubber to steel.

The use of semisynthetic resins, such as cellulose acetate, in the manufacture of artificial silk is well known. Within the past year, new fibers derived from purely synthetic resins have appeared upon the market. "Vinyon," a polyvinyl resin manufactured in fiber form, is now available in fabrics and Du Pont's Nylon made its public debut in silk stockings at the 1939 World's Fairs. Nylon is already on the market in the form of bristles and filaments which have achieved success in toothbrushes, hairbrushes, and dermal sutures.

Finally, there are many miscellaneous applications of thermoplastic resins, among which two may be picked at random—Paracoumarone, used as a binder in composition floor tile (and, incidentally, as an important component of chewing gum), and "Vistanex," derived from petroleum cracking gases and used as an agent to flatten the viscosity curve of lubricating oils, asphalts, and the like.

### Chemosetting Resins

The chemosetting resins can be only briefly mentioned. Aside from hard rubber, horny products resulting from the hardening of casein with formaldehyde were the first plastics of this type to be manufactured. They have long been used in the production of artificial jewelry and buttons. They have assumed renewed importance in England, today, where the army has replaced its shiny brass

uniform buttons with somber casein plastics less conspicuous in the dark. During the last two or three years an Italian invention has led to world-wide exploitation of a process for the production of so-called "Lanital" (artificial wool) from casein.

The alkyd resins, modified with drying oils, are chemosetting because they dry by oxidation. Both drying and nondrying oil-modified alkyds are used commercially in large quantities as lacquer resins. In 1938, over 40,000,000 lb. were produced for use in automobile lacquers and similar products.

### Elastomers

In addition to the classes of plastics already discussed, there is the more or less indefinite group of synthetic elastomers. They have provided the engineer with important "synthetic rubbers" resistant to oil, chemicals, aging, and flexing. "Neoprene," "Thiokol," "Koroseal," "Vistanex," and "Perbunan" are well known. "Resistoflex," made from polyvinyl alcohol, is a newcomer. Copolymers of vinyl acetate and vinyl chloride are also manufactured for this purpose. The latest arrival to this group of elastomers is "Polythene," now being made in England in limited amounts by polymerization of ethylene. An important application of the latter product is in cable sheathings and for this purpose it is said to have proved especially useful since German sources of polyvinyl chloride, previously employed for this service, have been shut off by the war.

### War-Time Significance of Plastics

In view of the present chaotic condition of international affairs, it is appropriate in closing to point out that the most important trend in the plastics industry during the past year has been toward increased use of its products by the armed forces of all the great powers. "Synthetic rubber" lined fuel tanks for bombing planes, laminated phenolic airplane members, laminated phenolic helmets, cellulose acetate mustard-gas-proof eyepieces, and luminescent molded phenolics and ureas for use during blackouts are but a few of their many important military applications. In war, as in peace, plastics have assumed a role of vital importance in the life of every nation.

# Comparative Properties of Moldable Plastics[1]

By Gordon Brown[2]

Because of the multiplicity of varieties in moldable plastics and their ever-widening scope of applications, the questions in the average mind relate to the fundamental differences in these various materials. Plastics form a world in themselves, with possibilities that grow daily. In spite of the fact that many of these products have been used commercially for thirty years, it is surprising how few engineers and other technical people are acquainted with their properties. Still fewer understand the differences in the properties of various types which control their suitability for one use or another.

In describing the differences in these various moldable plastics, we find ourselves leaping nimbly from one characteristic to another in a dozen different materials, and as each material has half a dozen essential characteristics, it is not long before the average person is completely confused.

A year ago the "Plastics Comparator" was evolved to aid the layman in determining what material is most suitable for a given application, and to simplify an understanding of the relative values of thermosetting and thermoplastic materials based upon tables showing relative

[1] Presented as part of a Symposium on Plastics held at a meeting sponsored by the A.S.T.M. Pittsburgh District Committee, January 29, 1940.

[2] Sales Manager, Bakelite Corp., New York, N. Y.

| PLASTIC MATERIAL | Toughness (Impact Strength) | Flexural Strength | Tensile Strength | Color | Cold Flow | Water Resistance | Acid Resistance | Caustic Resistance | Solvent Resistance | Dimensional Change on Aging | Heat Resistance | Flammability | Heat Insulation | Specific Gravity | Hardness | Loss Factor | Resistivity | Dielectric Strength | Moldability Around Inserts |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Phenolic: General Purpose | 10 | 3 | 3 | 7 | 1 | 6 | 3 | 4 | 1 | 4 | 2 | 3 | 2 | 8 | 5 | 10 | 7 | 4 | 1 |
| Phenolic: Low-Loss | 8 | 3 | 7 | 7 | 1 | 3 | 4 | 4 | 1 | 2 | 3 | 1 | 7 | 12 | 3 | 4 | 3 | 3 | 1 |
| Phenolic: Heat-Resistant | 10 | 4 | 8 | 7 | 1 | 3 | 4 | 4 | 1 | 1 | 1 | 1 | 7 | 13 | 2 | ○ | 8 | 8 | 1 |
| Phenolic: Acid and Alkali-Resistant | 11 | 6 | 8 | 7 | 1 | 4 | 2 | 3 | 1 | 5 | 3 | 2 | 2 | 5 | 4 | ○ | ○ | 7 | 2 |
| Phenolic: Shock-Resistant | 2 | 1 | 5 | 7 | 1 | 7 | 4 | 5 | 1 | 6 | 3 | 4 | 3 | 10 | 5 | ○ | 9 | 8 | 1 |
| Phenolic: Transparent | 7 | 1 | 3 | 7 | 1 | 4 | 2 | 3 | 1 | 5 | 3 | 2 | 2 | 6 | 4 | 7 | 5 | 6 | 2 |
| Urea | 9 | 1 | 1 | 1 | 2 | 9 | 4 | 4 | 1 | 7 | 7 | 5 | 5 | 11 | 1 | 9 | 4 | 1 | 3 |
| Polystyrene | 7 | 4 | 7 | 5 | 4 | 1 | 1 | 1 | 3 | 3 | 6 | 6 | 1 | 1 | 6 | 1 | 1 | 2 | 5 |
| Cellulose-Acetate | 4 | 6 | 9 | 4 | 8 | 11 | 4 | 6 | 3 | 9 | 5 | 6 | 4 | 7 | 9 | 8 | 6 | 5 | 4 |
| Aceto-Butyrate | 1 | 5 | 10 | 4 | 6 | 8 | 4 | 4 | 3 | 8 | 4 | 6 | 6 | 4 | 8 | 3 | ○ | ○ | 4 |
| Ethyl-Cellulose | 3 | 2 | 6 | 3 | 7 | 10 | 4 | 2 | 3 | 8 | 5 | 6 | 4 | 2 | 8 | 2 | 2 | 1 | 4 |
| Methyl-Methacrylate | 6 | 1 | 4 | 2 | 5 | 5 | 2 | 2 | 3 | 8 | 9 | 6 | 2 | 3 | 7 | 5 | ○ | 2 | 5 |
| Vinyl (No Filler) | 5 | 1 | 2 | 6 | 3 | 2 | 1 | 2 | 2 | 3 | 8 | 6 | 2 | 9 | 7 | 6 | 3 | 1 | 4 |

The Plastics Comparator

values for various properties. The Comparator, reproduced herewith, is a summary of the individual tables and can be used quickly and easily.

In using the Comparator it should be remembered that relative property values of the various materials are changing from day to day due to the improvements in the materials and in methods of manufacturing them. The 1940 Comparator is up to date as of the first of this year, but is likely to become obsolete within a few months.

The Comparator has been prepared to indicate, first, whether plastics are suitable for a given application, and, second, which type of plastic material is most likely to meet the requirements of the manufacturer. No attempt has been made to include price, because price varies so greatly, dependent on design and quantity. The Comparator will impress the observer with the necessity of balancing one desirable property against another, but when two or three attributes, including price, vie closely with one another as determining factors, it becomes necessary to call the expert. In spite of the fact that many data have been collected on modern plastic materials, it still requires a broad background of experience to assist in the determination of what particular plastic will best suit each individual requirement of practical use.

In order to assist in clarifying certain differences between the various types of materials, the present paper was based largely on some simple demonstrations, rather than on the enumeration of definite property values. Since a description of such demonstrations is inadequate in providing a proper understanding, they do not form suitable matter for publication.

## Overflow Attendance at Chicago District Meeting on Plastics

With an attendance exceeding that of any local meetings sponsored by the District Committees and two interesting talks on the live subject "Plastics," the meeting sponsored by the Chicago District Committee on March 27 at the Palmer House, Chicago, was an outstanding success. The room selected by the committee for the meeting was filled to overflowing with members of the Society and their friends and guests. It was estimated that about 600 people tried to get into the room, but quite a number were forced to hear the talks from the outside.

The District Committee under the chairmanship of D. L. Colwell, Paragon Die Casting Co., with C. E. Ambelang, Public Service Co. of Northern Illinois, *Secretary*, had planned a different type of meeting. The early starting time (7:15 p.m.), the elimination of the usual dinner, and the publicity to attract younger men were all prearranged by the Program Committee, headed by J. F. Calef, Automatic Electric Co., to test the desirability of such a plan in bringing out a good attendance.

President Morgan represented the Executive Committee and extended greetings to those present, explaining some of the Society's activities to the nonmembers. His opening remarks were followed by the first paper presented by W. A. Zinzow, Chief Physicist, Bakelite Corp. He gave an unusually instructive talk on the general philosophy of testing and specific properties and test methods of numerous plastic materials. This paper was supplemented with excellent slides which made an interesting comparison of the properties of these materials. Since this paper should be of widespread interest to engineers and those interested in plastics, it will probably be published in a forthcoming issue of the Bulletin.

S. P. Miller, Sales Engineer, E. I. du Pont de Nemours and Co., Inc., followed with a popular entertaining talk in which the properties of various thermoplastic molding materials were described and clearly demonstrated by samples and test apparatus. A brief history of cellulose nitrate, followed by later developments, such as the cellulose acetate, methacrylate materials, Nylon, and Butacite, was covered by Mr. Miller. His talk received a very favorable reception on the part of the large crowd present.

In the meeting room and adjoining hall were exhibits of molded articles displayed through the courtesy of the Bakelite Corp. and E. I. du Pont de Nemours and Co., Inc. These displays were thoroughly examined by many of those present and the District Committee has indicated its appreciation to the companies making the instructive displays possible. During the meeting several motion pictures were also shown.

The unusually large attendance is indicative of the widespread interest in plastics. It was gratifying to the District Committee to have such a successful program. Its success would indicate that more meetings of this type will probably be held by the Chicago District Committee.

## Stanton Walker Fellowship Established

The National Sand and Gravel Association has established a graduate fellowship at the University of Maryland with the purpose of advancing researches on appropriate problems relating to this industry. Suitable appropriations have been made to carry the fellowship for two years.

In honor of Stanton Walker, Director of the Association's Engineering and Research Division, the fellowship has been identified with his name, the Board of Directors feeling that this would be a fitting testimonial not only to Mr. Walker's personal standing in the industry but also to the high value of his accomplishments in the engineering and research fields.

Mr. Walker has been very active for many years in various phases of the work of the Society. He is a member of a number of technical committees and has served as an officer of several of the subgroups. At the present time he is also rendering very helpful service as a member of Committee E-6 on Papers and Publications, particularly with respect to fields involving concrete, concrete aggregates, and related road and paving materials. As announced in this Bulletin he is a nominee for the Society's Executive Committee. Recently he was appointed a Director of the American Concrete Institute.

# Standardization in the Field of Mechanical Packing

By F. C. Thorn[1]

In 1938 there was organized under the chairmanship of Mr. William Staniar, E. I. du Pont de Nemours & Co., Inc., a subcommittee of A.S.T.M. Committee D-11 on Rubber Products entitled Subcommittee VI on Packings, Gaskets and Pump Valves. The membership of this subcommittee comprises representatives of companies manufacturing and using mechanical packing. Its agreed-upon program is to work toward correcting the admittedly unsatisfactory situation existing, because of lack of standardization, in the field of test methods for packing, and purchase specifications based thereon.

The first steps in such a program are to agree upon definitions of terms, limit the scope of the program, and survey existing conditions within the allotted scope. Appropriate sections were accordingly set up. In the field of nomenclature a surprising degree of confusion was found to exist. For its own guidance the subcommittee accepted at its recent meeting in Detroit, the following set of definitions:

*A Packing* (singular) is a nonrigid article designed for inclusion in the wall of a fluid container to prevent or minimize leakage between the rigid parts of such container.

*Packing* (collective) is an aggregate of individual packings, or material in sheet, coil, or bulk form from which packings may be prepared.

*A Gasket* is a packing for insertion between parts of a fluid container in essentially stationary relationship.

*Gasketing* is material in sheet, coil, or bulk form from which gaskets may be prepared.

*A Valve Disk* is a specialized gasket designed to constitute the working face of a rigid valve and to improve its tightness when closed.

*A Diaphragm* (in the packing sense) is a specialized packing designed for inclusion between parts of a fluid container in limited relative motion, and designed to absorb this motion by its own deformation.

*Diaphragm sheet* is sheet from which diaphragms may be cut.

Regarding scope, it was agreed that the work would be limited to packings containing rubber, or a rubber-like plastic, as a major ingredient. This is a natural consequence of the position of the subcommittee within Committee D-11 on Rubber Products. A tentative classification of such packings was proposed, as follows:

| | Forms Recommended for Subcommittee Action |
|---|---|
| I.—*Gaskets* (Including sheet or strip from which gaskets are intended to be cut): | |
| A. Rubber compounds without fabric reinforcement or a high percentage of fiber. | Rubber sheet |
| B. Rubber compounds with a high percentage of fiber | Compressed asbestos sheet |
| C. Rubber compounds with fabric reinforcement | |
| (1) Cotton fabric | |
| (*a*) Sheet (or strip cut from sheet), (*b*) Rolled or folded strip, and (*c*) Gaskets prepared from preceding forms with or without subsequent molding | Cotton insertion sheet |
| (2) Asbestos fabric | |
| (*a*) Sheet (or strip cut from sheet), (*b*) Rolled or folded strip, and (*c*) Gaskets prepared from preceding forms with or without subsequent molding | Asbestos insertion sheet |
| (3) Wire fabric (sheet only) | Wire insertion sheet |
| D. Rubber compounds with reinforcement of twisted or braided asbestos yarns | |
| II.—*Valve Disks:* | |
| A. Rubber compounds without fabric reinforcement or high percentage of fiber | Pump valves and disks for globe valves |
| B. Rubber compounds with a high percentage of fiber | Disks for globe valves |
| C. Rubber compounds with fabric reinforcement | |
| III.—*Sliding Contact Packings* (including sheet or strip from which rings, etc., are intended to be cut): | |
| A. Rubber compounds without fabric reinforcement or high percentage of fiber | |
| B. Rubber compounds with high percentage of fiber | Rubber-bonded plastics (doubtful) |
| C. Rubber compounds with fabric reinforcement | |
| (1) Cotton fabric | |
| (*a*) Sheet (or strip cut from sheet), (*b*) Rolled or folded strip, and (*c*) Rings (or other forms) prepared from preceding forms with or without subsequent molding | "Low pressure" spiral hydraulic coil round piston packing |
| (2) Asbestos fabric | |
| (*a*) Sheet (or strip cut from sheet), (*b*) Rolled or folded strip, and (*c*) Rings (or other forms) prepared from preceding forms with or without subsequent molding | "High pressure" spiral |
| D. Rubber compounds reinforced with twisted or braided yarns, wires or metal foil strips | Rubber bonded asbestos valve stem packing; rubber bonded metal foil constructions (doubtful) |
| IV.—*Diaphragms* (including sheet from which diaphragms are intended to be cut): | |
| A. Rubber compounds without fabric reinforcement | |
| B. Rubber compounds with fabric reinforcement | |
| (1) Cotton fabric | |
| (*a*) Sheet (or strip cut from sheet), (*b*) Diaphragms molded from preceding | Diaphragm sheet |
| (2) Asbestos fabric | |
| (*a*) Sheet (or strip cut from sheet), (*b*) Diaphragms molded from preceding | |

It was also agreed that attention should be confined to those rubber packings which are used in general plant maintenance, which are purchased by practically all industries, railroads, and municipalities, and which are shown in the last column above. Specialty packings, such as purchased by the Navy, by automobile, airplane and other equipment manufacturers are considered, for the

[1] Secretary, Subcommittee VI on Packings, Gaskets and Pump Valves, Committee D-11 on Rubber Products; Chief Chemist, The Garlock Packing Co., Palmyra, N. Y.

immediate future, to be outside of the scope of the subcommittee as now constituted.

A special section on Survey addressed a questionnaire to federal departments, and, in addition, to 119 railroads, steamship lines, municipalities, and industrial firms requesting information as to their practices in purchasing packings of the types indicated. Of 53 replies received from other than federal departments, only 15, or 12.6 per cent of those addressed, employ any specifications at all, and very few of these have specifications covering more than a few of the enumerated items. Where it was possible to secure an expression of opinion regarding specification purchasing of packings, the reaction was somewhat spotty, some firms being apparently satisfied with the results obtained, others uncertain, and still others definitely of the opinion that specification purchasing did not lead to any benefits commensurate with the time and trouble entailed.

As illustrating the state of confusion prevalent in the field, comparisons were made in parallel columns, of specifications applicable to single items. Thus, in the field of ordinary sheet rubber gasketing, we find the specifications shown in Table I in effect.

We find the specifications to be completely divergent in respect to:

(*a*) The kind of tests to be employed,
(*b*) The manner of applying them, and
(*c*) The minimum (or maximum) values demanded.

In fact there is such a divergence that the uninitiated reader would hardly be expected to know that all these companies are trying to purchase the same product; that is, a sheet rubber gasketing for ordinary flange service against water, air, and (possibly) low-pressure steam. It is hardly necessary to point out that this situation adds to the cost of producing sheet rubber packing, both with respect to the diversity of products which must be produced and the cost of conducting the tests themselves. It is also hardly necessary to point out that this added cost is eventually borne by the purchaser.

Similar situations, which it is unnecessary to summarize here, were found to exist among the specifications applicable to (*a*) compressed asbestos sheet, (*b*) cotton inserted sheet, (*c*) asbestos inserted sheet, (*d*) folded boiler gaskets, and (*e*) wire inserted sheet. In the fields of pump valves, valve disks, diaphragm sheet, duck - rubber spiral, asbestos - rubber spiral, specifications were too few to permit extended comparison, but it is apparent that the writing of specifications in respect to these products also is in a very unsatisfactory state.

The section working on the above survey has concluded that the fundamental difficulty with writing specifications is that nobody knows what correlation, if any, exists between the various laboratory tests and service. (Editor's Note.—A paper on "Service Tests for Packing" by Mr. Thorn, presented at a meeting of Subcommittee VI of Committee D-11 in Atlantic City, June 29, 1938, is published in the December 1938 ASTM BULLETIN, p. 29.) The first duty of the subcommittee will be to determine what existing laboratory tests can be shown to correlate with service, and to concentrate on these to the exclusion of all others. The second will be to simplify and standardize these tests so that reproducible values can be obtained as between different laboratories. The third will be to develop new tests which will be equally simple and reproducible and perhaps correlate even closer with service than any of the existing tests. The question of limiting values to be assigned—that is, the actual promulgation of material specifications—is properly postponed until the end of the program.

An effort is now being made to organize special sections each dealing with a particular type of packing. The subcommittee will be glad to hear from any engineers who may have ideas or suggestions respecting any specifications and test methods for packing.

TABLE I.—SPECIFICATION REQUIREMENTS.

| Purchaser | Specific Gravity | Chemical Requirements | Hardness | Tensile Strength, psi. | Elongation, per cent | Set | | Aging | | | | Special Tests |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | After Stretching, per cent | Max., per cent | Days | Oven Temperature, deg. Fahr. | Maximum Decline, per cent | | |
| | | | | | | | | | | Tensile Strength | Elongation | |
| Railroad—A | 1.70 to 2.38 | "Salmon color" | ..... | 650 min. | 200 min. | ... | .. | .. | ... | .. | .. | 3 days in steam at 307 F. (between flanges) |
| B | ..... | ..... | ..... | ..... | 100 min. | ... | .. | .. | ... | .. | .. | 1 hr. in air at 300 F.; also a compression test |
| C | 1.74 to 2.09 | Ash—65 to 75 per cent | ..... | 450 min. | 125 to 250 min. | ... | .. | .. | ... | .. | .. | 6 hr. in air at 212 F. |
| D | ..... | ..... | ..... | 900 min. | 250 min. | ... | .. | 7 | 158 | 25 | .. | 7 hr. in air at 300 F. (between flanges); also 48 hr. in 45 lb. steam; also swelling test in cold water |
| E | ..... | "Red antimony rubber or equivalent" | ..... | 700 min. | 200 min. | 200 | 38 | .. | ... | .. | .. | 1 hr. in air at 250 F.; also compression test |
| F | ..... | ..... | ..... | 500 min. | ..... | ... | .. | .. | ... | .. | .. | ..... |
| G | 1.39 to 2.09 | ..... | ..... | 400 min. | 75 min. | ... | .. | .. | ... | .. | .. | 6 hr. in air at 300 F. |
| Municipality | ..... | ..... | ..... | 500 min. | 150 min. | ... | .. | .. | ... | .. | .. | 1 hr. in air at 260 F. |
| Industrial—A | 2.04 max. | Non-blooming | ..... | 750 max. | 200 min. | 150 | 20 | 4 | 158 | 25 | 25 | ..... |
| B | 1.75 to 1.80 | Red | 80 to 85[a] | 900 min., Length 800 min., Cross | ..... | ... | .. | 7 | 158 | 10 | .. | ..... |
| Federal[b] | 175 max. | Rubber by vol., 60 per cent, min. | ..... | 1000 min. | 350 min. | 300 | 25 | 4 | 158 | 25 | .. | 4 hr. in steam at 366 F. (between flanges) |

[a] Shore Durometer.
[b] The Federal Specification and possibly some of the others have undergone changes since the date of this survey but the changes have not been in the direction of greater uniformity.

# Observations on the Strength of Certain Highway Aggregates

By Fred G. Allison[1]

Since highway traffic is in general wholly supported, directly or indirectly, by mineral fragments of one sort or another, it is quite important that state highway departments devote a large amount of study to the characteristics of such fragments, individually and in masses, both bonded and unbonded. In studying and testing these fragments, commonly called aggregates, in laboratories, two major avenues of approach have been followed. By one of these, samples are analyzed, or "taken apart," in an effort to measure more or less individual qualities. In this manner, sieve, moisture, toughness, abrasion, chemical, and other tests may be made. By the second avenue, aggregates are built up into various test specimens, sometimes being combined with cementing agents in accordance with special formulas which have been more or less standardized, and they are then tested in the belief that, to some degree, practical service conditions have been simulated. Through comparing the results of these two lines of study with actual highway construction experience, present-day specifications for many materials have been evolved.

It has been more or less realized for a long time that the two avenues of approach to the study of highway aggregates do not parallel each other and that neither one nor both combined yield a perfect guarantee of ultimate performance for any aggregate under all conditions. Although the best information at hand has been and is being used, it is generally felt that improved methods are needed. Probably the great need is for more research, more detailed analysis of causes rather than effects, more emphasis on a diagnostic attitude. The purpose of this paper is to add a little to such analysis and such an attitude through the presentation of test data and a simple method for comparing the fiber strengths of mineral fragments.

## Isolation of Sand Qualities

Of the numerous aggregate materials examined by highway laboratories, sands are not only very important in many types of construction, but they are easy to use for the purpose of demonstrating those basic physical laws which underlie the behavior of many materials. In fact, a close study of concrete sands should have a broad applicability to the use of all aggregates. In a recent discussion of structural strength tests on concrete sands (*1*),[a] attention was directed to the fact that in certain mortar strength tests aimed at evaluating such sands all of a considerable assortment of sand qualities are measured as a complex, with little discrimination as between individual basic characteristics. Thus, purity, sieve grading, fiber strength, angularity, and surface texture are usually measured as a grand total, providing limited information as to true causes. To isolate all of these various characteristics of a concrete sand and measure their effects separately seems quite difficult, but some progress has been made. Although it is well known that the purity of a concrete sand is very important, particularly insofar as it may affect chemical actions within a mortar or concrete, in the present studies no effort has been made to determine the effect of impurities. The question of purity was eliminated at the start by using carefully selected materials. The effort here is to submit evidence bearing on the effects of sieve grading, fiber strength, angularity, and surface texture in the order mentioned.

## Experimental Gradings Used

It has long been known that the sieve grading of a sand has a marked effect on the strength of its cement mortar and concrete. Therefore, in undertaking the tests reported here, the first step was to sieve and recombine experimental sands according to systematic formulas. Five different concrete sand gradings were selected, each falling within well-established specifications. One of the five is an average grading, while the other four represent possible extremes. The five gradings used in the tests reported here, together with type designations, are shown in Table I.

TABLE I.—EXPERIMENTAL CONCRETE SAND GRADINGS USED.

| Grading | | Sieve Sizes, per cent by Weight | | | | |
|---|---|---|---|---|---|---|
| Number | Type | 3 to 4 | 4 to 16 | 16 to 50 | 50 to 100 | Passing 100 |
| 1 | Coarse | 5.0 | 35.0 | 55.0 | 5.0 | 0.0 |
| 2 | Fine | 0.0 | 5.0 | 65.0 | 25.0 | 5.0 |
| 3 | Ends | 5.0 | 35.0 | 30.0 | 25.0 | 5.0 |
| 4 | Center | 0.0 | 5.0 | 90.0 | 5.0 | 0.0 |
| 5 | Average | 0.5 | 11.0 | 73.0 | 13.0 | 2.5 |

Note.—All of these gradings comply with numerous state highway specifications as well as those given in the Society's Standard Specifications for Concrete Aggregates (C 33 – 39).[2]

## Sand Gradings *versus* Tensile Strength

For many years the so-called "structural strength" of concrete sands has been measured in highway laboratories by means of the Society's Standard Methods of Sampling and Physical Testing of Portland Cement (C 77 – 39),[3] or by very similar means. This calls for tension briquets made with a 1:3 mortar and a comparison with similar briquets made with the same cement and standard Ottawa sand. If a proposed concrete sand meets the general grading specifications, there is no readjustment of that grading prior to the test so as to make it comply with any precise formula. The method is quite well known. Employing this method, and selecting a natural silica sand which has been satisfactory for concrete over

TABLE II.—EFFECT OF SAND GRADING ON TENSILE STRENGTH OF CEMENT MORTARS MADE WITH SILICA SAND.

| Type of Grading | 7-day Strength, psi. | 28-day Strength, psi. |
|---|---|---|
| Coarse | 513 | 590 |
| Fine | 450 | 597 |
| Ends | 538 | 637 |
| Center | 430 | 540 |
| Average | 468 | 582 |

Note.—Tested according to Standard Methods C 77, used for many years for measuring the "structural strength" of proposed concrete sands.

[1] Formerly Research Engineer, Georgia State Highway Department, Atlanta, Georgia. Note: Manuscript prepared in March, 1939.

[a] The italic numbers in parentheses refer to the list of references appended to this paper.

[2] 1939 Book of A.S.T.M. Standards, Part II, p. 281.

[3] 1939 Book of A.S.T.M. Standards, Part II, p. 17.

TABLE III.—EFFECT OF CERTAIN VARIABLES ON THE STRENGTH OF CEMENT MORTAR CUBES MADE ACCORDING TO STANDARD METHODS C 87–39.[a]

| Test Number | Type of Grading | Sp. Gr. Dry Sand | Voids in Dry Sand, per cent | Grams of Dry Sand in Batch | Abs. Vol. of Sand in Batch, ml. | Sp. Gr. Voidless Mortar | Bulk Sp. Gr. Surface Dry Cubes | Avg. Wt. Surface dry Cubes, g. | Avg. Vol. Cubes, cu. in. | Avg. total 7-day Compressive Strength | Avg. Total 28-day Compressive Strength |
|---|---|---|---|---|---|---|---|---|---|---|---|
| G 1 | Coarse | 2.64 | 32.3 | 1678 | 635.6 | 2.218 | 2.283 | 295.2 | 7.89 | 15 733 | 28 700 |
| G 2 | Fine | 2.64 | 33.5 | 1400 | 530.3 | 2.178 | 2.230 | 289.1 | 7.91 | 16 233 | 28 100 |
| G 3 | Ends | 2.64 | 31.3 | 1740 | 659.1 | 2.227 | 2.275 | 295.3 | 7.92 | 17 100 | 28 533 |
| G 4 | Center | 2.64 | 37.9 | 1440 | 545.5 | 2.184 | 2.200 | 284.5 | 7.89 | 13 800 | 25 200 |
| G 5 | Average | 2.64 | 33.5 | 1410 | 534.1 | 2.179 | 2.230 | 290.2 | 7.93 | 16 200 | 28 866 |
| General Average for Sand "G" | | | 33.7 | 1533.6 | 580.9 | 2.197 | 2.246 | 290.86 | 7.91 | 15 815 | 27 880 |
| DT 1 | Coarse | 2.64 | 32.3 | 1860 | 704.5 | 2.242 | 2.278 | 298.7 | 8.00 | 15 100 | 23 900 |
| DT 2 | Fine | 2.64 | 34.6 | 1570 | 594.7 | 2.203 | 2.234 | 293.6 | 8.02 | 15 600 | 24 750 |
| DT 3 | Ends | 2.64 | 29.8 | 1910 | 723.5 | 2.247 | 2.290 | 298.2 | 7.94 | 16 800 | 27 400 |
| DT 4 | Center | 2.64 | 36.8 | 1550 | 587.1 | 2.201 | 2.222 | 291.7 | 8.01 | 13 800 | 23 500 |
| DT 5 | Average | 2.64 | 33.5 | 1650 | 625.0 | 2.215 | 2.215 | 290.7 | 7.93 | 14 450 | 23 675 |
| General Average for Sand "DT" | | | 33.4 | 1708 | 647.0 | 2.222 | 2.252 | 294.6 | 7.98 | 15 150 | 24 645 |
| Ca 1 | Coarse | 2.69 | 38.0 | 1380 | 513.0 | 2.194 | 2.250 | 292.9 | 7.94 | 16 500 | 26 200 |
| Ca 2 | Fine | 2.69 | 39.0 | 1170 | 434.9 | 2.155 | 2.191 | 286.1 | 7.97 | 15 733 | 24 266 |
| Ca 3 | Ends | 2.69 | 35.9 | 1420 | 527.9 | 2.201 | 2.233 | 291.9 | 7.97 | 15 100 | 24 433 |
| Ca 4 | Center | 2.69 | 41.9 | 1270 | 472.1 | 2.174 | 2.155 | 282.8 | 8.00 | 13 633 | 21 750 |
| Ca 5 | Average | 2.69 | 40.0 | 1190 | 442.3 | 2.181 | 2.163 | 285.5 | 8.00 | 13 966 | 22 500 |
| General Average for Sand "Ca" | | | 38.96 | 1286 | 478.1 | 2.181 | 2.198 | 287.8 | 7.99 | 14 986 | 23 830 |
| SS 1 | Coarse | 2.78 | 37.9 | 1460 | 525.2 | 2.243 | 2.302 | 301.1 | 7.98 | 18 466 | 29 900 |
| SS 2 | Fine | 2.78 | 40.0 | 1180 | 424.5 | 2.188 | 2.214 | 290.3 | 8.00 | 17 733 | 27 933 |
| SS 3 | Ends | 2.78 | 34.6 | 1470 | 528.8 | 2.245 | 2.285 | 299.4 | 7.99 | 19 600 | 28 266 |
| SS 4 | Center | 2.78 | 41.0 | 1290 | 464.0 | 2.211 | 2.221 | 291.0 | 7.99 | 16 733 | 25 566 |
| SS 5 | Average | 2.78 | 37.9 | 1280 | 460.4 | 2.209 | 2.237 | 293.0 | 7.99 | 17 800 | 27 766 |
| General Average for Sand "SS" | | | 38.25 | 1336 | 480.6 | 2.219 | 2.252 | 295.0 | 7.99 | 18 066 | 27 886 |
| Mar 1 | Coarse | 2.72 | 37.6 | 1500 | 551.5 | 2.226 | 2.288 | 301.4 | 8.03 | 16 050 | 24 800 |
| Mar 2 | Fine | 2.72 | 37.6 | 1230 | 452.2 | 2.178 | 2.237 | 293.75 | 8.01 | 17 250 | 25 750 |
| Mar 3 | Ends | 2.72 | 34.3 | 1580 | 580.9 | 2.239 | 2.295 | 303.15 | 8.06 | 18 050 | 27 075 |
| Mar 4 | Center | 2.72 | 39.7 | 1270 | 466.9 | 2.185 | 2.207 | 290.05 | 8.02 | 15 150 | 25 200 |
| Mar 5 | Average | 2.72 | 37.6 | 1310 | 481.6 | 2.193 | 2.232 | 291.9 | 7.98 | 16 300 | 25 675 |
| General Average for Sand "Mar" | | | 37.4 | 1378 | 506.6 | 2.204 | 2.252 | 296.0 | 7.02 | 16 560 | 25 900 |
| Average of Five Coarse Sands | | | 35.62 | 1578 | 586.0 | 2.225 | 2.280 | 297.6 | 7.97 | 16 370 | 26 700 |
| Average of Five Fine Sands | | | 36.94 | 1510 | 487.3 | 2.180 | 2.221 | 290.6 | 7.98 | 16 510 | 26 160 |
| Average of Five Ends Sands | | | 33.18 | 1624 | 604.0 | 2.232 | 2.276 | 297.6 | 7.98 | 17 330 | 27 100 |
| Average of Five Center Sands | | | 39.46 | 1364 | 507.1 | 2.191 | 2.201 | 288.0 | 7.98 | 14 623 | 24 240 |
| Average of Five Average Sands | | | 36.50 | 1368 | 508.7 | 2.195 | 2.220 | 290.3 | 7.98 | 15 743 | 25 700 |
| Grand Average of All Tests | | | 36.34 | 1448.4 | 538.6 | 2.205 | 2.240 | 291.9 | 7.98 | 16 115 | 25 980 |

[a] 1939 Book of Standards, Part II, p. 304.

a large region (sand "G" of Table III), sets of tension briquets were made, using the various gradings shown in Table I, and were broken at the customary 7- and 28-day intervals. The results of these tests are shown in Table II. In spite of there being a high probable error in this test method, it is shown that the "ends" grading yields the greatest strength, while the "center" grading yields the lowest. This has long been a well-recognized fact, as Anderegg has recently pointed out (*2*), but it deserves clear restatement in the present connection.

### Effects of Many Variables on Mortar Cube Qualities

A newer method for measuring the "structural strength" of concrete sands is the Society's Standard Method of Test for Structural Strength of Fine Aggregate Using Constant Water-Cement-Ratio Mortar (C 87–39).[4] This calls for compression tests on cured cubes or cylinders, made with proposed sands. In the present studies 2-in. cubes were used. As in the case of Method C 77, there is no preliminary adjustment of sieve grading. A constant water-cement ratio is used and the quantity of sand added to the previously made paste is regulated by flow-table tests so that a uniform consistency of mortar is obtained for each test. In Table III are presented results of tests made by this method, very slightly modified. The sand gradings of Table I were again used, as in the tests reported in Table II. Certain supplementary tests on the dry sand and on the cubes are also reported. Five different sands were used, as follows: Sands "G" and "DT" are natural silica sands of good quality which have been extensively used with satisfactory results. Sand "Ca" is a granite "stone sand," highly angular in character, well established in use for concrete. Sand "SS" is a dolomitic limestone "stone sand," also highly angular in character, but normally crushing so that individual fragments are somewhat "flatter" than many other "stone sands." Sand "Mar" was prepared in the laboratory from a seemingly soft, coarse-grained marble. All five sands were carefully resieved and compounded in the laboratory.

### Tentative Conclusions from Mortar Cubes

There are many significant, although tentative, conclusions which might be derived from Table III, but space limitations restrict a full statement at this time. Five outstanding points deserve present consideration. (1) Assuming that this testing procedure is scientifically sound, the grading of the sand appears at least partially to control the strength of the cubes. Evidently Method C 87 is similar to Method C 77 in that respect. (2) The absolute volume of sand in the batches of fresh mortar varied from 423.5 ml. with sand "SS 2" to 723.5 ml. with sand "DT 3," the latter being 170 per cent of the former. Is the "structural strength" of a sand to be derived from the compressive strength of the mortar by recalculating to a "pound for pound" basis? (3) With the large variations in quantity of sand used in the different batches of mortar, there is a corresponding variation in the cement factors. How, then, could these results be applicable to a blanket concrete mixture design which calls for a minimum cement factor? (4) In spite of considerable occlusion of air during the mixing operation, the bulk specific gravity of the sur-

[4] 1939 Book of A.S.T.M. Standards, Part II, p. 304.

face dried cubes is generally greater than the theoretically possible bulk specific gravity of their air-free mortars. Thus, the loss of water during the early stages of the curing of these cubes more than offsets air occlusion. Are both air occlusion and water loss considered functions of interstice size, or capillary friction? (5) Possibly most important of all, sand "Mar," judging solely from the data presented in Table III, has a satisfactory "structural strength." This evidence indicates that Method C 87, as now broadly written into many specifications, fails to reveal low fiber strength in a proposed concrete sand. To learn whether or not sand "Mar" would be shown as having low fiber strength when tested by Method C 77, sets of tension briquets were made with it, again using the gradings shown in Table I. The results of these tests are presented in Table IV. An examination of this table fails to show any pronounced weakness for the mortar made with marble. Again, as in the case of variations in grading, Methods C 87 and C 77 agree.

TABLE IV.—EFFECT OF SAND GRADING ON TENSILE STRENGTH OF CEMENT MORTARS, USING PREPARED SOFT MARBLE AS SAND.

| Type of Grading | 7-day Strength, psi. | 28-day Strength, psi. |
|---|---|---|
| Coarse | 468 | 610 |
| Fine | 388 | 540 |
| Ends | 553 | 640 |
| Center | 430 | 512 |
| Average | 497 | 572 |
| Standard Ottawa sand | 375 | 485 |

NOTE.—Tested according to Standard Methods C 77.

### MORTARS OBSCURE LOW FIBER STRENGTH

Within cement mortars and concretes there is a complex system of compensations which tends to obscure certain characteristics of component parts. Examining the last column of figures in Table III, one may wonder just why certain cubes appeared to be stronger than others. The effect of sand grading appears to be more or less isolated, but other characteristics seem to be confused. Although most specifications for concrete sand state that the grains shall be hard and durable, mortar strength tests seem wholly inadequate to guarantee such qualities in a sand. Moreover, no standard test has been available for measuring the fiber strength of sand. There are abrasion tests for coarse aggregate, but they are on the order of grindability tests (3), for they measure the effects of angularity and surface texture as well as fiber strength. There are wear tests on finished specimens of mortar and concrete which, though valuable, are not closely analytical. Fiber strength is an individual quality of sands not brought out by any of the older tests for mortars, concrete, and aggregates. Because of this, efforts were made to develop a test which would yield at least approximate values for the fiber strengths of sands and similar materials. The method is still in an elementary stage, but it is believed that it shows sufficient promise of merit to deserve presentation.

### NEW METHOD FOR FIBER STRENGTH

This new method for comparing fiber strengths consists of crushing a definite quantity of a prepared sand, or other aggregate, in a strong, closed, steel cylinder by means of a close fitting piston, and obtaining a pressure-voids curve.

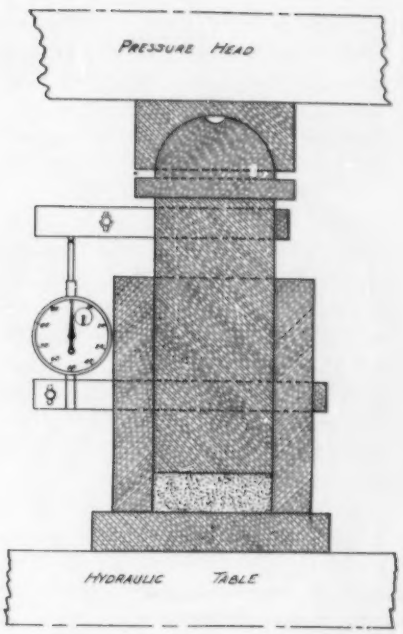


**Fig. 1.—Fiber Strength Tester.**

A large universal testing machine and an Ames dial are used, both instruments being read simultaneously. Sands are sieved, and the No. 20 to No. 30 fraction has been used for the test, although other sizes may prove satisfactory. Apparent specific gravity tests are made on each sample tested. For each test, an amount of sand is weighed into the cylinder which, in consideration of its apparent specific gravity, will yield a theoretically possible inch of depth (absolute volume) in a 3-in. diameter cylinder. With an apparent specific gravity of 2.64, the amount of sand used in the cylinder is 305.8 g. Readings of the Ames dial are easily recalculated into terms of total air voids in the sand being tested. Records may be made from the beginning of the test so that a reasonably full pressure-voids curve can be drawn, or readings may be made at any desired points, such as 30, 25, and 20 per cent total air voids in the sand. There is no end point in this test which corresponds to the "break" of a set mortar or the "ultimate" for a tension

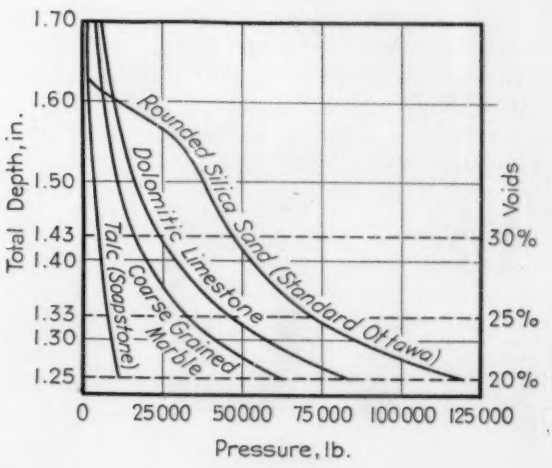


**Fig. 2.—Fiber Strength Graphs.**

test specimen. The method is entirely one of comparisons, employing a measurable degree of deformation. Consequently, details may be readily modified and adapted to almost any testing laboratory. Figure 1 shows the general arrangement of the very simple testing device.

### Pressure-Voids Curves

As was expected, when one of these fiber strength tests begins, the shape of the particles has a marked effect on the pressure-voids curve. A highly angular sand yields a curve that is distinctly different from one produced by a sand with rounded particles. This is illustrated in Fig. 2. However, after the pressure develops to a certain extent, the significance of original particle shape seems to disappear and, it is believed, the shapes of the new fragments created by the crushing are characteristic of the mineral matter of which the sand is composed. It is not claimed that this method possesses a very high degree of either accuracy or precision, but it does supply a means for giving numerical values to the fiber strengths of mineral fragments with much greater certainty than do mortar strength tests or any other, known, simple method. In mineralogy the hardness of talc is called one and that of the diamond is called ten, with other minerals falling along a straight line curve thus established. The values derived from this present fiber strength test may be thought of as possessing a somewhat similar significance. The basic principle of the test is similar in many respects to methods of comparison now in industrial use. In the glass industry, the hardness of glass is measured by grinding a flat surface under controlled conditions and the amount of material removed is considered a measure of hardness (*4*). In the mining industry, experts on ore dressing have found that the horsepower required to crush a ton of a specific ore bears a constant relation to the total surface area of the product (*5*).

### Principles Establishing Mortar and Concrete Strengths

In Table V are presented the results of various fiber strength tests, including tests on the sands used in making the cubes reported in Table III. It is immediately evident, upon comparing these two tables, that there is little correlation between fiber strength and the strength of the mortar. To what, then, can one attribute the variations in mortar strength? The sands used were pure; grading was largely eliminated by careful compounding; and fiber strength has been evaluated by measuring it more or less directly. Of our original group of sand characteristics, enumerated above, we seem to have only angularity and surface texture left as "unknowns." In considering the effect of these two latter characteristics of concrete sand, it seems appropriate to restate some basic viewpoints with regard to the design and behavior of mortars and concretes. It seems to have been claimed for many years that the strength of a mortar or concrete depends largely upon the strength of its cured paste. According to Gilkey (*6*) that is now the prevailing view, although he is one of those who have doubted it for some time. Certainly it is not strictly true and never has been, for the strength of mortars or concretes, like that of many other bonded aggregates, depends upon the strength of the weakest potential rupture path (or flow path)—and that is decidedly different.

TABLE V.—COMPARATIVE FIBER STRENGTHS OF VARIOUS MINERAL FRAGMENTS AS SHOWN BY THE METHOD DESCRIBED IN THIS PAPER.

| Material Tested | Pressure at 30 per cent Voids, psi. | Pressure at 25 per cent Voids, psi. | Pressure at 20 per cent Voids, psi. |
|---|---|---|---|
| Standard Ottawa sand | 46 500 | 72 000 | 123 500 |
| Glass beads | 44 000 | 62 000 | 95 000 |
| Talc | 4 800 | 7 600 | 11 400 |
| Sand "G" | 38 500 | 73 000 | 146 000 |
| Sand "DT" | 37 000 | 70 000 | 136 000 |
| Sand "Ca" | 31 000 | 60 500 | 116 000 |
| Sand "SS" | 24 000 | 46 000 | 85 000 |
| Sand "Mar" | 19 500 | 39 000 | 77 000 |

NOTE.—All materials between the No. 20 and No. 30 sieves. One-inch depth of absolute volume in a 3-in. cylinder. Uniform speed of hydraulic table in all cases.

### The Rupture Paths Principle

There is a generalization which seems to have been in the minds of students of bonded aggregates for many years and which is well worth repeating. Assuming a type of bonded aggregate in which the bonding agent is inherently weaker than the aggregate being bonded; assuming ideal homogeneity of the bonding agent and of the aggregate material; and assuming a perfect union between the two—then the following must be true: these bonding agents, even though quite weak in themselves may impart great strength to the mass as a whole through two actions. First, they may hold the aggregate units in position to prevent slipping, and, second, when skillfully proportioned, usually in minimum amounts, they may supply a path of rupture potentially so devious, and with so greatly increased an area, that the gross resistance to stress through such a path is greater than that presented by a less devious path which passes partly, or largely, through the aggregate. Thus, the unit strength of the whole may, with increasing skill in design to that end, tend to approach that of the aggregate material itself. The exact extent to which this principle applies to cement mortars and concretes is definitely debatable, as Gilkey suggests (*6*). Possibly it does work out to a large degree with certain bituminous highway mixtures and subgrade soils. The asphalt paving technologists have added materially to our understanding of what now seems to be the chief reason for the principle having limited practical applicability. Beginning with the early work of Nicholson (*7*), highway engineers have learned much about the interfacial relations between aggregate and bituminous bonds. McLeod (*8*) has presented a clear statement with regard to the surface chemistry and physics of bituminous mixtures.

### Surface Texture and Boundary Effects

In his recent excellent work on boundary effects, Weymouth (*9*) has aided a great deal in the diagnosis of the behavior of cement mortars and concretes. He has particularly helped toward understanding, and partially evaluating, the importance of surface texture of concrete constituents. A lot of glass beads, such as are sometimes used in making reflecting highway markers, was sifted so as to obtain a quantity which fell between the No. 20 and No. 30 sieves, thus matching standard Ottawa sand in respect to size, and to a considerable degree in other respects. Using Standard Methods C 77, two sets of tension briquets were made and broken at 7 and 28 days. The results of these tests are shown in Table VI, Standard Ottawa sand being used as a control with the same cement.

TABLE VI.—"BOUNDARY EFFECT" ON TENSILE STRENGTH OF CEMENT MORTARS—GLASS BEADS *VERSUS* OTTAWA SAND.

| | 7-day Strength, psi. | 28-day Strength, psi. |
|---|---|---|
| Standard Ottawa sand | 362 | 472 |
| Glass beads | 258 | 257 |

NOTE.—Tested according to Standard Methods C 77.

It will be noted from Table VI that the briquets made with the glass beads were not only much weaker than those made with the Ottawa sand, but the mortar did not increase in strength between 7 and 28 days, although the Ottawa sand briquets did so in the expected manner. The operator who broke these briquets commented that the cement did not "stick to" the beads. However, it is doubtful whether or not adhesion, strictly defined, had anything at all to do with it. There are several ways in which two materials may be joined. An examination of the broken ends of these briquets showed that the glass beads seemed to be stripped clean of paste on the exposed side, while the Ottawa grains had many small flakes of cement paste attached to their surfaces. Here was a striking illustration of the "rupture paths principle" combined with "boundary effect." Because of the fact that, to the naked eye, standard Ottawa grains look very smooth, many persons are but little aware of the fact that they are relatively rough and that this roughness is exceedingly significant. Figure 3 shows a photomicrograph of the surface of a grain of standard Ottawa sand at about 160 diameters. Obviously, the smooth surface of the glass beads provided the rupture path of least total resistance, not simply because of being the shortest, but, chiefly, because it was the weakest on account of the boundary effect. With the Ottawa sand, the boundary effect may have been just as great (per unit of true area) as with the glass beads, but, due to the condition shown in Fig. 3, the actual area of that boundary was so much greater that a rupture path partly through the main body of the paste was the weakest.

### On Separating the Effects Due to Angularity and to Surface Texture

For many years concrete laboratories have made routine records of the nature of the fracture when test cylinders were broken. Sometimes cylinders break largely through the mortar whereas sometimes a great deal of the coarse aggregate is sheared. Those persons who have tested cement mortars and concretes in highway laboratories for a period of years would have little hesitancy in presenting an explanation as to why sand "SS," as shown in Tables III and V, might produce a mortar with a higher compressive strength than sand "Ca," even though its apparent fiber strength is less and the cement factor is practically the same. Due to angularity, the fragments of sand "SS" overlap, or bridge, to a greater extent, so that the weakest rupture path passes not only through more of "SS" than of "Ca," but enough to more than offset its lower fiber strength. If it were definitely known that the attachment of the paste to the sand grains was the same in both cases, that might be the correct explanation, but there is no direct evidence with regard to that. It is logical to suppose that, due to the nature of the stresses applied, angularity and surface texture of concrete sand grains should function differently with tension tests than with compression tests. Possibly angularity means more in compression, and surface texture means more in tension.

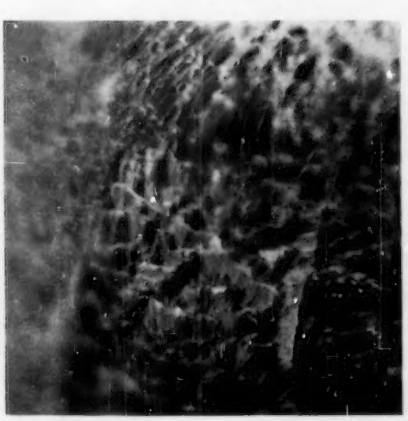

Fig. 3.—Standard Ottawa Sand Grain (160 X)

### A Possible Surface Area Effect

A quantity of sand "G," described in connection with Table III, was sieved into separate sizes and tension briquets were made in accordance with Standard Methods C 77. The same cement was used in all cases and each batch of mortar consisted of 750 g. of sand, 250 g. of cement and 112 ml. of water. Standard Ottawa sand briquets, made by the same formula, were used as a control and all four batches were carried along together. The results of these tests are shown in Table VII. An examination of these data brings up the question as to why the smallest grains made the mortar with the lowest tensile strength. The mixture ratios were the same in all cases, but the smallest grains have the largest surface area per unit of weight and one would expect the mortar made from the finest sand to have the largest potential rupture path following entirely through the paste. If there were perfect adhesion or attachment between this sand and the paste, the tensile strength of the finest sand mortar should be the greatest. As the reverse is true, the only possible explanation is that these measurements of tensile strength reflect, to some degree, the strength of the interfacial attachment multiplied by the surface area of the sand at the rupture path. Of course, the strength of the main body of the paste in the interstices was an important contributor, but just how important *no one knows!* These results might be considered as more or less paralleling those reported in Table VII, which show the effects produced by glass beads. Both groups of tests concentrate attention on the interfacial relations and tend to corroborate the views of Weymouth (9).

### Various Kinds of Attachment Within Concrete

A certain amount of portland cement does not hydrate in practical use, but acts more or less as aggregate. Even within the part which does hydrate, it is probable that

TABLE VII.—A POSSIBLE SURFACE AREA EFFECT ON TENSILE STRENGTH OF MORTAR.

| Sand Used | Sieve Grading | 7-day Strength, psi. | 28-day Strength, psi. |
|---|---|---|---|
| "G" | No. 4 to No. 16 | 393 | 532 |
| "G" | No. 16 to No. 50 | 393 | 507 |
| "G" | No. 50 to No. 100 | 343 | 455 |
| Standard Ottawa | No. 20 to No. 30 | 395 | 472 |

NOTE.—Tested in accordance with Standard Methods C 77.

there are distinct variations in density, microscopic in scope. There is a sense in which the less dense zones might be considered as binder for the more dense zones. Possibly that is carrying the conception of aggregate a little too far for many uses, but it is a point worth considering. When the cement sets up, there is a crystalline interlocking and joining which makes the paste as a whole virtually monolithic. The less active particles take on a type of crystalline unity with those parts which are, or were, more active. It seems proper to call this action, or joining, cohesion. Within a grain of sand there is a similar cohesion. In a cement mortar, at the interface between the paste and a sand grain, there may be, in addition to a boundary effect, mechanical keying and adhesion. The mechanical keying which may take place is easy to understand, but we still know very little about the adhesion between cement paste and aggregates. No evidence has come to hand which shows that there may not be chemical or electrical affinities between cement paste and aggregates somewhat similar to those which exist between bituminous materials and aggregates. Examining the test data here presented, it is not hard to suspect that there might be an affinity between cement paste and sands "SS" and "Mar," both of which are calcareous, different in nature from that between cement paste and the other sands shown in Table III. It should be possible to obtain experimental data on this point. For some years past, practical concrete mixture design has strongly emphasized the absolute volumes of various constituents and paid little attention to the total surface area of different aggregates. It is conceivable that new knowledge of boundary effects and interfacial relations could modify that emphasis.

## Conclusions

A tacit acceptance of the *status quo* of highway technology as it affects the use and testing of aggregates is not justifiable in view of possible improvements through research.

The "structural strength" of a mineral fragment is made up of many properties which can be and should be isolated and measured individually. Only by so doing can a comprehensive diagnosis of the behavior of highway aggregates be advanced.

So-called "orthodox" theories concerning the design of bonded aggregates deserve the most critical examination. The "rupture paths principle" seems to be fundamental and should never be ignored.

An easy method for measuring the fiber strength (the internal strength) of mineral fragments is presented which promises to add to our knowledge of construction materials.

The surface texture of aggregates appears to contribute much more to mortar and concrete strength than many have assumed.

A comprehensive study of the interfacial relations between cement paste and concrete aggregates may yield much of value.

Certain routine test methods for highway aggregates, now in vogue, have many decidedly debatable features, for a testing procedure can obscure as well as reveal.

*Acknowledgments:*

The observations here reported were carried out as part of the regular research program of the State Highway Board of Georgia.

The photomicrograph of Fig. 3 is by the Division of Laboratories, Georgia State Department of Public Health.

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(6) H. J. Gilkey, *Proceedings*, Am. Soc. Testing Mats., Vol. 38, Part II, p. 380 (1938).
(7) Victor Nicholson, *Proceedings*, Assn. Asphalt Paving Technologists, January, 1932, p. 28.
(8) Norman W. McLeod, *Proceedings*, Assn. Asphalt Paving Technologists, December, 1937, p. 1.
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## Survey of Research in Industry

The National Research Council has acceded to a request of the National Resources Planning Board to undertake a survey of scientific research in industry. Since industry and business are depending more and more upon the use of scientific knowledge, it is hoped the findings will be of definite benefit to industry.

The study will not be a census of scientific men or an inventory of equipment, nor an enumeration of the projects of research in which industrial laboratories are now engaged. Rather it is desired to visualize the significant trends which the development of research has taken through these laboratories in various industries, many of which in newer fields are based largely on the direct application of scientific knowledge to manufacture. Discussion of the present relation of research to the growth of a number of the major industries will be included. Another portion of the survey will deal with the extent to which the recognized disciplines of science—physics, chemistry, mathematics, metallurgy, the several fields of engineering, biology, and certain borderline fields—are applied in different industries. A history of the development of the research idea in industrial operations, and certain economic aspects of the development of research in industry, and a comparison of industrial research abroad with its growth in this country will also be included in the report.

To take charge of this survey the Council has appointed a committee of which F. W. Willard, Nassau Smelting and Refining Co., is Chairman. The committee is composed largely of industrial executives and research directors, and representatives of universities active in industrial research. The immediate direction of the survey has been placed by the Council in the hands of Raymond Stevens, Vice-President, Arthur D. Little, Inc., Cambridge, Mass.

# Hydrostatic Test Pressures for Pipe[1]

## Proposed Standard Specification Requirements

EDITOR'S NOTE.—Intensive work by Committee A-1 on Steel's Subcommittees IX on Pipe and Tubing, T. G. Stitt, Chairman, and XXII on Valves, Fittings, Piping and Flanges for High-Temperature Service, A. E. White, Chairman, has resulted in 30 A.S.T.M. specifications for various kinds and classes of pipe and tubing. This large number of standards is necessitated by the wide diversity of products covered, the range of service, and the various uses in many fields such as plumbing, heating, gas and oil lines, boiler and superheater tubes, still tubes, etc. Both subcommittees have had difficult and involved problems to handle, and the solution of many of these has been of benefit to both the consumer and producer. While the particular section headed by Mr. Redington and responsible for this report originated in Subcommittee IX, the work is also of direct concern to Subcommittee XXII, several of whose members are on the section.


### SUMMARY

CONSIDERATION OF inconsistencies in the existing hydrostatic test pressure requirements of certain steel pipe specifications led Subcommittee IX on Steel Tubing and Pipe of Committee A-1 on Steel to appoint a special section to investigate the facts and report its recommendations. Two specifications in particular were to be studied, covering welded and seamless steel pipe (A 53 – 36) and black and hot-dipped zinc-coated (galvanized) welded and seamless pipe for ordinary uses (A 120 – 36). Test pressures for smaller size pipe and heavier walled pipe were especially to be considered.

The findings and recommendations of the section were submitted at the 1940 January A-1 meetings. The accompanying Tables I and II were approved. Table I published primarily as information, although it is predicated on the simplest form in which most of the factors involved are included, covers too much detail for practical use as a specification table. Table II is a modification of Table I and with certain changes to bring it in line with sizes covered, is intended to be included in the specifications A 53 and A 120.

It will be noted that the maximum test pressure is 2800 psi. When the findings of the committee were explained to Subcommittee XXII on Valves, Fittings, Piping and Flanges for High-Temperature Service, it took action also to modify the requirements in three of its specifications so that the maximum pressure of 2800 psi. would be effective, but with the provision that subject to special arrangement between producer and consumer, the test may as an alternate be 1 1/2 times the working pressure for pipe in sizes 14 in. nominal diameter and smaller providing the fiber stress does not exceed one-half the minimum specified yield point. The Subcommittee XXII specifications cover lap-welded and seamless steel pipe for high-temperature service (A 106 – 39), seamless alloy-steel pipe for service at temperatures from 750 to 1100 F. (A 158 – 38 T), and seamless carbon-molybdenum alloy-steel pipe for service at temperatures from 750 to 1000 F. (A 206 – 39 T).

Since the recommendations and findings of the section might be of interest to many A.S.T.M. members, both producers and consumers of piping and tubing, the Steel Committee recommended the publication in the ASTM BULLETIN of the Section's report. With the details as a matter of record for future reference, the thought was that if a subcommittee should be interested in modifying present test pressures for tubular products, they may possibly secure some guidance from the work of the present section.


### GENERAL DISCUSSION

The hydrostatic testing of pipe has been one of the several standard mill inspection tests ever since modern pressure pipe has been made. The detailed methods used have necessarily varied somewhat for different mills and for different sizes and classes of pipe, but fundamentally, the basic principle has been the same. Usually the length of pipe has been placed in the testing pump between a movable head and an adjustable buggy, held in place by head or end pressure, filled with water, the internal pressure raised to a predetermined number of pounds per square inch, the pressure held for a given period of time, the material inspected for leakage, internal pressure released, pipe emptied, and length removed for further finishing operations.

However, there have been different mill practices, widely varying maximum mill pump capacities, many size ranges and various wall thicknesses, different classes of pipe, such as butt weld, lap weld, seamless, electric fusion weld, etc., and also various grades of material—bessemer, open hearth, and those designated A, B, and C. As a consequence detailed mill testing procedure for a given size, wall, and class may be said, with no thought of criticism, to have grown somewhat like "Topsy." In later years, when standard specifications began to be prepared for pipe for the different service conditions, definite requirements for hydrostatic testing were gradually adopted and became standard mill practice. Here again, however, detailed requirements differed widely. Each group preparing such specifications was primarily interested in a standard procedure for the testing of pipe for a certain type of service, and the testing requirements naturally followed certain more or less well-defined practices known and required by those familiar with the fabrication and use of that particular class of material at that time, rather than because the detailed tests fitted in to some general test plan.

The detailed test pressure requirements varied according to whether the pipe was to be used for plumbing and heating and ordinary building construction purposes or for gas and oil lines, oil well tubing and casing, drive pipe, drill pipe, boiler tubes, water transmission and distribution lines, process piping, etc. Even as late as 1936, a review of A.S.T.M. specifications for pipe for high-tem-

[1] Report submitted by the Section on Hydrostatic Test Pressures, of Subcommittee IX on Steel Tubing and Pipe, Committee A-1 on Steel, with the following personnel: H. R. Redington, *Chairman*, Sabin Crocker, E. L. Johnson, S. H. Kilmer, N. L. Mochel, J. J. Shuman, J. A. Smail, J. R. Tanner.

Courtesy National Tube Co.

Pressure Test Pump—26 In.

perature and high-pressure service, boiler tubes, superheater tubes, still tubes, large diameter pipe for water lines, etc., found that this same nonuniformity of test requirements still existed and that the testing requirements ran the gauntlet all the way from a flat test pressure of 1000 psi. for some classes and grades of material to detailed graduated requirements for each size, class and wall thickness. In between these requirements were eight or ten variations based on formula, such as:

(1) $P = \frac{2St}{D}$ where $P$ = hydrostatic test pressure, $S$ = allowable fiber stress of 12,000 psi., $t$ = wall thickness in inches, and $D$ = outside diameter in inches.

(2) The same formula where $S$ = 0.50 times the minimum specified yield point, with a maximum of 2500 psi. for 3 in. and under in outside diameter; 4500 psi. for sizes 3 in. up to but not including 8 in. in outside diameter; and 3000 psi. for all sizes 8 in. and over.

(3) The same formula where $S$ = 16,000 to 18,000 psi. for Grade A; 20,000 to 22,000 psi. for Grade B; with a maximum pressure of 2500 psi. and stress not more than 80 per cent of the specified yield point.

(4) One hundred and fifty per cent of the working pressure, but in no case shall the maximum stress produced exceed 36 per cent of the minimum tensile strength specified.

(5) The same formula where $S$ = 14,000 to 16,000 psi. for Grade A; 16,000 to 18,000 psi. for Grade B; with a maximum of 80 per cent of the specified yield point.

(6) Same formula where $S$ = 0.75 times the minimum yield point.

(7) $P = \frac{32{,}000t}{D}$ with maximum of 2500 psi. and 4500 psi., according to size, etc.

(8) All of these requirements and others are accompanied by time limits for holding pressure—"not less than 5 sec.," 6 sec., etc., or no time limits; with varying methods for jarring certain pipe while under pressure—near both ends; at 6-in. intervals, etc.; and with different weight hammers—2 lb.; not over 10 lb.; etc.

There appeared no logical reason for so many conflicting requirements. Perhaps a broad review might be in order, to find out what we really are trying to accomplish —what can the mills do—what is the purpose? Thus to go back for a moment.

## History: Relation of Hydrostatic Test and Service Pressures

It is probable that the original idea behind hydrostatic pressure testing was to indicate flaws in material, determine the soundness of welds, etc., and since working pressures used were relatively low the hydrostatic pressures usually considerably exceeded the service pressures. Prior to 1928, for instance, service presures and temperatures in the power industry were comparatively low and the usual hydrostatic test was considered much more severe than any pressure likely to be encountered in service. While the designing engineer undoubtedly kept in mind some relation between the test pressures and service pressures, the former was so much above the service that he would not have to worry about the ability of the pipe to withstand the pressure in service.

With the advent of higher service pressures and temperatures, the significance of the hydrostatic test has changed so that there now is an increasing demand from designing engineers that pipe be tested to a definite proportion of its tensile strength, and in no case less than $1^1/_2$ times the actual working pressure. As mentioned below one of the recent committee actions will provide that by agreement between the purchaser and producer certain sizes of pipe for high-temperature service may be tested to such pressures.

There was also a growing tendency on the part of designing engineers to specify exact wall thicknesses calculated from the working stresses, in which case they felt it was essential that a formula be provided to calculate the test pressure. This resulted in the general tendency in the early '30's to step up the maximum pressures, especially where the material was to be used for high temperatures and high-pressure work. However, it can readily be seen that the mill hazards involved, and the special equipment required, to test light and heavy wall material in the small and large sizes, at the higher pressures have, over the years, raised practical mill operating problems.

As far back as 1936 it was well recognized by some, that unless hydrostatic test pressures were put on a sound and more rational basis, groups charged with developing standard specifications would have difficulty in selecting suitable test pressures. In 1936 the Society, on the recommendation of the Steel Committee, adopted a revision in standard specifications for lap-welded and seamless steel pipe for high-temperature service (A 106) and seamless alloy-steel pipe for service at temperatures from 750 to 1100 F. (A 158) which provided for the inclusion of the so-called schedule numbering system with flat test pressures listed for each schedule.

*Editor's Note.*—These schedule numbers were developed by Sectional Committee B36 functioning under the procedure of the American Standards Association sponsored by the A.S.T.M. and the A.S.M.E. They are incorporated in the American Standard B36.10-1939 covering wrought-iron and wrought-steel

pipe. The table showing the standard sizes and giving dimensions of welded and seamless steel pipe, including the schedule numbers is part of specifications A 106 and is also given in the appendix in certain of the steel specifications including A 158, A 120, and A 53.

Several consumers immediately questioned these test pressures, their contention being that although they ordered pipe to a specification such as A 106 for a supposedly superior product for high-pressure work, yet the actual mill hydrostatic test pressures required were not so high as if they had ordered the material to other specifications, such as A 53, A.P.I. line pipe, etc.

Of course, the fundamental reason why a uniform test pressure cannot be assigned to a series such as "standard weight" or "extra strong" is due to the fact that the wall thicknesses throughout a given series are not consistent. In other words, if a given stress is selected for a particular material, and a series analyzed by means of Barlow's formula, the allowable pressure and hence the hydrostatic test will vary greatly. These inconsistencies were one of the reasons why Sectional Committee B 36 was formed, that is, to provide new schedules below, between, and above present schedules in which the thicknesses were determined on a logical basis. If this is done, a single test pressure should suffice for a series. The fact that test pressures in the three specifications indicated were inconsistent is not a reflection on the values of any one of them but rather illustrates the inconsistencies manifest in the old series of wall thicknesses and hydrostatic pressures.

The lack of uniformity of hydrostatic test pressures was discussed at various times and finally in May, 1936, the Subcommittee on Tubular Products of the American Association of Steel Manufacturers' Technical Committees expressed to Subcommittee XXII its desire to cooperate in an effort to equitably adjust the pressure requirements of the various pipe specifications involved in the field of high temperatures and pressures. This led to studies by the manufacturing group involving mill practice, maximum pump capacities, and various specification requirements.

First recommendation from the group after study was based on the A.P.I. specifications 5-L covering line pipe. With certain maximum fiber stress values, depending upon the grade of pipe, the maximum test pressure was not to exceed 2500 psi. In 1937 A.S.T.M. specifications A 158 were changed to provide that pipe should be tested to a pressure which would produce in a wall a stress of 50 per cent of the specified yield point calculated from the formula $P = \frac{2St}{D}$ with provisions same as the second case shown above under General Discussion. Then specifications A 106 were brought in line with A 158.

During the summer of 1938 certain consumers raised questions about the test requirements of specifications A 53 and A 120, particularly on the smaller sizes and heavier walls. The manufacturers suggested that while it would be well to effect changes it would be better to consider the whole question of hydrostatic testing and base any changes for A 53 and A 120 on some broad principle of proper testing, so that all tubular specifications for both low and high pressures could be gradually brought in line in an effort to standardize and simplify mill testing procedure.

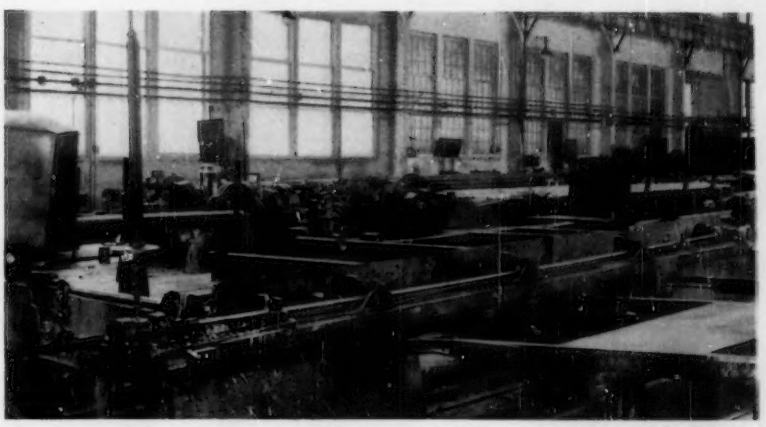
This led to the appointment of the Section on Hydrostatic Test Pressures early in 1939.

The first table of revised hydrostatic test pressures presented for approval included only pipe of the old classification, that is, "standard," "extra strong," and "double extra strong" steel pipe. This table showed proposed test pressures for butt weld, lap weld, and Grades A, B, and C seamless and electric welded pipe. The bursting pressures were listed along with the test pressures for comparison and to show that test pressures in definite proportion to bursting pressures are not practical in regular mill production. The maximum test pressure listed was 2800 psi., based on the mill's ability to test with present equipment.

This table was revised and expanded to include all of the sizes and wall thicknesses in the Standard B 36.10-1939 with schedule numbers and the bursting pressures still listed (see accompanying Table I). Table I is made up so that modifications of it can be applied to all A.S.T.M. specifications covering pipe in the sizes and walls included in the Schedule Number classification.

Most of the comments received from members of Subcommittee IX to whom the table was referred for review suggested a modification of the proposed table with maximum pressures that were beyond the present mill pump capacities. The proposed revisions included modified tables showing only one test pressure for each Schedule Number and tables showing pressures in size groups. From the suggestions received and with due consideration for the capacities of mill equipment, a modified table (see accompanying Table II) was drafted in which test pressures for all grades were shown grouped in five size ranges. This greatly reduced the number of test pressures and will make for mill simplicity and economy in testing the various sizes and weights.

This modified table has been approved for incorporation in Specifications A 120 and A 53, except that Grade C will be eliminated, since this grade is not included in these specifications, and the "low carbon" and "medium carbon" steel grades will be designated Grades A and B.



**Test Pump—Small Sizes.**

*Courtesy National Tube Co.*

TABLE I.—HYDROSTATIC TEST PRE

Butt Weld, Lap Weld, Electric Weld, and Seamless Pipe (Sizes and Weights Correspond to Schedule Numbe
(A 106 – 39)—Also see American Standard for Wrought-

| Nom. Pipe Size, in. | Out-Side Diam-eter in. | Schedule 10 | | | Schedule 20 | | | Schedule 30 | | | Schedule 40 | | | | Schedule 60 | | | Schedule 80 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Grade A and Lap Weld* | Grade B | Grade C | Grade A and Lap Weld* | Grade B | Grade C | Grade A and Lap Weld* | Grade B | Grade C | Butt Weld | Grade A and Lap Weld* | Grade B | Grade C | Grade A and Lap Weld* | Grade B | Grade C | Butt Weld | Grade A and Lap Weld* | Grade B |
| 1/8 | 0.405 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 700 | 700 | 700 | 700 | ... | ... | ... | 850 | 850 | 850 |
| | | ... | ... | ... | ... | ... | ... | ... | ... | ... | *13 432* | *16 790* | *20 148* | *25 185* | ... | ... | ... | *18 764* | *23 457* | *28 148* |
| 1/4 | 0.540 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 700 | 700 | 700 | 700 | ... | ... | ... | 850 | 850 | 850 |
| | | ... | ... | ... | ... | ... | ... | ... | ... | ... | *13 036* | *16 292* | *19 550* | *24 438* | ... | ... | ... | *17 628* | *22 037* | *26 444* |
| 3/8 | 0.675 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 700 | 700 | 700 | 700 | ... | ... | ... | 850 | 850 | 850 |
| | | ... | ... | ... | ... | ... | ... | ... | ... | ... | *10 784* | *13 480* | *16 176* | *20 220* | ... | ... | ... | *14 932* | *18 666* | *22 399* |
| 1/2 | 0.840 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 700 | 700 | 700 | 700 | ... | ... | ... | 850 | 850 | 850 |
| | | ... | ... | ... | ... | ... | ... | ... | ... | ... | *10 380* | *12 972* | *15 566* | *19 458* | ... | ... | ... | *14 000* | *17 500* | *21 000* |
| 3/4 | 1.050 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 700 | 700 | 700 | 700 | ... | ... | ... | 850 | 850 | 850 |
| | | ... | ... | ... | ... | ... | ... | ... | ... | ... | *8608* | *10 760* | *12 912* | *16 140* | ... | ... | ... | *11 732* | *14 666* | *17 599* |
| 1 | 1.315 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 700 | 700 | 700 | 700 | ... | ... | ... | 850 | 850 | 850 |
| | | ... | ... | ... | ... | ... | ... | ... | ... | ... | *8088* | *10 114* | *12 137* | *15 171* | ... | ... | ... | *10 888* | *13 612* | *16 334* |
| 1 1/4 | 1.660 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 800 | 1000 | 1100 | 1300 | ... | ... | ... | 1100 | 1500 | 1600 |
| | | ... | ... | ... | ... | ... | ... | ... | ... | ... | *6744* | *8434* | *10 121* | *12 651* | ... | ... | ... | *9204* | *11 506* | *13 807* |
| 1 1/2 | 1.900 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 800 | 1000 | 1100 | 1300 | ... | ... | ... | 1100 | 1500 | 1600 |
| | | ... | ... | ... | ... | ... | ... | ... | ... | ... | *6104* | *7632* | *9158* | *11 448* | ... | ... | ... | *8420* | *10 526* | *12 631* |
| 2 | 2.375 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 800 | 1000 | 1100 | 1300 | ... | ... | ... | 1100 | 1500 | 1600 |
| | | ... | ... | ... | ... | ... | ... | ... | ... | ... | *5184* | *6484* | *7781* | *9726* | ... | ... | ... | *7340* | *9179* | *11 011* |
| 2 1/2 | 2.875 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 800 | 1000 | 1100 | 1300 | ... | ... | ... | 1100 | 1500 | 1600 |
| | | ... | ... | ... | ... | ... | ... | ... | ... | ... | *5648* | *7061* | *8473* | *10 592* | ... | ... | ... | *7680* | *9600* | *11 520* |
| 3 | 3.500 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 800 | 1000 | 1100 | 1300 | ... | ... | ... | 1100 | 1500 | 1600 |
| | | ... | ... | ... | ... | ... | ... | ... | ... | ... | *4936* | *6171* | *7405* | *9257* | ... | ... | ... | *6856* | *8571* | *10 285* |
| 3 1/2 | 4.000 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1200 | 1300 | 1600 | ... | ... | ... | ... | 1700 | 1800 |
| | | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | *5650* | *6780* | *8475* | ... | ... | ... | ... | *7950* | *9540* |
| 4 | 4.500 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1200 | 1300 | 1600 | ... | ... | ... | ... | 1700 | 1800 |
| | | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | *5267* | *6320* | *7901* | ... | ... | ... | ... | *7489* | *8987* |
| 5 | 5.563 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1200 | 1300 | 1600 | ... | ... | ... | ... | 1700 | 1800 |
| | | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | *4638* | *5565* | *6957* | ... | ... | ... | ... | *6741* | *8089* |
| 6 | 6.625 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1200 | 1300 | 1600 | ... | ... | ... | ... | 1700 | 1800 |
| | | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | *4326* | *5071* | *6339* | ... | ... | ... | ... | *6321* | *7585* |
| 8 | 8.625 | ... | ... | ... | 1000 | 1200 | 1600 | 1200 | 1300 | 1700 | ... | 1300 | 1600 | 2000 | 1700 | 2000 | 2500 | ... | 2100 | 2400 |
| | | ... | ... | ... | *2899* | *3478* | *4348* | *3212* | *3854* | *4818* | ... | *3733* | *4480* | *5600* | *4707* | *5649* | *7061* | ... | *5797* | *6956* |
| 10 | 10.750 | ... | ... | ... | 850 | 1000 | 1300 | 1000 | 1200 | 1500 | ... | 1200 | 1400 | 1800 | 1700 | 2000 | 2500 | ... | 2000 | 2300 |
| | | ... | ... | ... | *2326* | *2791* | *3488* | *2856* | *3427* | *4284* | ... | *3395* | *4074* | *5093* | *4651* | *5581* | *6977* | ... | *5516* | *6619* |
| 12 | 12.750 | ... | ... | ... | 700 | 800 | 1100 | 950 | 1100 | 1400 | ... | 1100 | 1300 | 1700 | 1600 | 1900 | 2400 | ... | 1900 | 2200 |
| | | ... | ... | ... | *1961* | *2353* | *2941* | *2588* | *3106* | *3882* | ... | *3184* | *3821* | *4776* | *4408* | *5289* | *6612* | ... | *5388* | *6466* |
| 14 O.D. | 14.000 | 650 | 750 | 950 | 800 | 950 | 1200 | 950 | 1100 | 1400 | ... | 1100 | 1300 | 1700 | 1500 | 1800 | 2300 | ... | 1900 | 2200 |
| | | *1786* | *2143* | *2679* | *2229* | *2674* | *3343* | *2679* | *3215* | *4019* | ... | *3121* | *3746* | *4682* | *4236* | *5083* | *6354* | ... | *5357* | *6429* |
| 16 O.D. | 16.000 | 550 | 650 | 850 | 700 | 800 | 1100 | 850 | 1000 | 1300 | ... | 1100 | 1300 | 1700 | 1500 | 1700 | 2200 | ... | 1900 | 2200 |
| | | *1563* | *1875* | *2344* | *1950* | *2340* | *2925* | *2344* | *2813* | *3516* | ... | *3125* | *3750* | *4688* | *4100* | *4920* | *6150* | ... | *5269* | *6322* |
| 18 O.D. | 18.000 | 500 | 600 | 750 | 600 | 750 | 950 | 850 | 1000 | 1300 | ... | 1100 | 1300 | 1700 | 1500 | 1700 | 2200 | ... | 1900 | 2200 |
| | | *1389* | *1667* | *2083* | *1733* | *2080* | *2600* | *2428* | *2913* | *3642* | ... | *3122* | *3747* | *4683* | *3989* | *4787* | *5983* | ... | *5206* | *6247* |
| 20 O.D. | 20.000 | 450 | 550 | 650 | 650 | 800 | 1000 | 850 | 1000 | 1300 | ... | 1100 | 1200 | 1600 | 1500 | 1700 | 2200 | ... | 1900 | 2200 |
| | | *1250* | *1500* | *1875* | *1875* | *2250* | *2813* | *2500* | *3000* | *3750* | ... | *2965* | *3558* | *4448* | *4060* | *4872* | *6090* | ... | *5155* | *6186* |
| 24 O.D. | 24.000 | 350 | 450 | 550 | 550 | 650 | 850 | 850 | 1000 | 1300 | ... | 1000 | 1200 | 1500 | 1400 | 1600 | 2100 | ... | 1800 | 2100 |
| | | *1042* | *1250* | *1562* | *1563* | *1875* | *2344* | *2342* | *2810* | *3512* | ... | *2863* | *3435* | *4294* | *3904* | *4685* | *5856* | ... | *5075* | *6090* |
| 30 O.D. | 30.000 | 350 | 450 | 550 | 600 | 700 | 900 | 750 | 850 | 1100 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| | | *1040* | *1248* | *1560* | *1667* | *2000* | *2500* | *2033* | *2500* | *3125* | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |

* In accordance with past practice, one test pressure has been listed for both Grade A seamless and lap weld material. Calculation of test pressures for sizes 8 in. and over in these columns, were based on the physical properties of Grade A steel. Because of the limited space in the table and because bursting pressures are listed only as additional information to assist in critical study of the table, theoretical bursting pressures for only Grade A material are listed in these columns. The theoretical bursting pressures for lap weld pipe may be determined by deducting the usual percentage from the Grade A bursting pressures listed.

**Notes:**

1. Figures in italics are theoretical bursting pressures based upon the following tensile strengths:

Butt Weld—40,000 psi.
Grade A—50,000 psi.
Grade B—60,000 psi.
Grade C—75,000 psi.
Grades A, B, and C cover seamless and electric weld.

TABLE II.—ALTERNATE TABLE (MODI

| Size, in. | Schedule 10 | | | Schedule 20 | | | Schedule 30 | | | Schedule 40 | | | Schedule 60 | | | Schedule 80 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | L.W. Grade A | Grade B | Grade C | L.W. Grade A | Grade B | Grade C | L.W. Grade A | Grade B | Grade C | *B.W. L.W. Grade A | Grade B | Grade C | L.W. Grade A | Grade B | Grade C | *B.W. L.W. Grade A | Grade B |
| 1/8 to 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 700 | 700 | 700 | .. | .. | .. | 850 | 850 |
| 1 1/4 to 3 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1000 | 1100 | 1300 | .. | .. | .. | 1500 | 1600 |
| 3 1/2 to 6 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1200 | 1300 | 1600 | ... | ... | ... | 1700 | 1800 |
| 8 to 16 | 600 | 700 | 900 | 850 | 950 | 1300 | 1000 | 1100 | 1500 | 1200 | 1400 | 1900 | 1600 | 1900 | 2400 | 2000 | 2200 |
| 18 to 30 | 450 | 550 | 650 | 600 | 700 | 950 | 800 | 950 | 1200 | 1000 | 1200 | 1600 | 1400 | 1700 | 2200 | 1900 | 2200 |

* Butt weld furnished in sizes 1/8 to 3 in.
[a] Prior to incorporation in the Standard Specifications for Welded and Seamless Steel Pipe (A 53 – 36) and for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses (A 120 – 36) changes will be made in the size range covered, limiting this to 12 in. footnote will be added indicating that butt-weld pipe is furnished in to 3 in., incl.

A streamlined table (see accompanying Table III) showing only one test pressure for all grades for each group of sizes under a given Schedule Number has been drafted in connection with possible further revision of Specification A 106. As in previous proposals, the maximum test pressure proposed for application in regular mill production is 2800 psi.

In determining test pressures for pipe in the butt weld size range, that is, sizes 1/8 in. to 3 in., inclusive, the governing factor was the capacity of present mill testing

THEORETICAL BURSTING PRESSURES.

...le III of A.S.T.M. Standard Specifications for Lap-Welded and Seamless Steel Pipe for High-Temperature Service ...t-Steel Pipe (A.S.A. B36.10-1939) and Line Pipe Specifications (A.P.I. 5-L)).

| Schedule 100 | | Schedule 120 | | | Schedule 140 | | | Schedule 160 | | | | Double Extra Strong | | | | Nom. Pipe Size, In. | Out-Side Diameter in. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grade B | Grade C | Grade A and Lap Weld* | Grade B | Grade C | Grade A and Lap Weld* | Grade B | Grade C | Butt Weld | Grade A and Lap Weld* | Grade B | Grade C | Butt Weld | Grade A and Lap Weld* | Grade B | Grade C | | |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1/8 | 0.405 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 1/4 | 0.540 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 3/8 | 0.675 |
| ... | ... | ... | ... | ... | ... | ... | ... | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1/2 | 0.840 |
| ... | ... | ... | ... | ... | ... | ... | ... | *17 810* | *22 262* | *26 714* | *33 393* | *28 000* | *35 000* | *42 000* | *52 500* | | |
| ... | ... | ... | ... | ... | ... | ... | ... | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 3/4 | 1.050 |
| ... | ... | ... | ... | ... | ... | ... | ... | *16 610* | *20 762* | *24 914* | *31 143* | *23 464* | *29 333* | *35 200* | *44 000* | | |
| ... | ... | ... | ... | ... | ... | ... | ... | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1 | 1.315 |
| ... | ... | ... | ... | ... | ... | ... | ... | *15 209* | *19 011* | *22 814* | *28 517* | *21 776* | *27 224* | *32 669* | *40 836* | | |
| ... | ... | ... | ... | ... | ... | ... | ... | 1200 | 1800 | 1900 | 2200 | 1200 | 1800 | 1900 | 2200 | 1 1/4 | 1.660 |
| ... | ... | ... | ... | ... | ... | ... | ... | *12 048* | *15 060* | *18 072* | *22 590* | *18 410* | *23 012* | *27 614* | *34 518* | | |
| ... | ... | ... | ... | ... | ... | ... | ... | 1200 | 1800 | 1900 | 2200 | 1200 | 1800 | 1900 | 2200 | 1 1/2 | 1.900 |
| ... | ... | ... | ... | ... | ... | ... | ... | *11 832* | *14 790* | *17 747* | *22 184* | *16 842* | *21 053* | *25 264* | *31 580* | | |
| ... | ... | ... | ... | ... | ... | ... | ... | 1200 | 1800 | 1900 | 2200 | 1200 | 1800 | 1900 | 2200 | 2 | 2.375 |
| ... | ... | ... | ... | ... | ... | ... | ... | *11 554* | *14 442* | *17 331* | *21 663* | *14 686* | *18 358* | *22 030* | *27 537* | | |
| ... | ... | ... | ... | ... | ... | ... | ... | 1200 | 1800 | 1900 | 2200 | 1200 | 1800 | 1900 | 2200 | 2 1/2 | 2.875 |
| ... | ... | ... | ... | ... | ... | ... | ... | *10 435* | *13 044* | *15 652* | *19 565* | *15 360* | *19 200* | *23 040* | *28 800* | | |
| ... | ... | ... | ... | ... | ... | ... | ... | 1200 | 1800 | 1900 | 2200 | 1200 | 1800 | 1900 | 2200 | 3 | 3.500 |
| ... | ... | ... | ... | ... | ... | ... | ... | *9989* | *12 486* | *14 983* | *18 729* | *13 714* | *17 143* | *20 572* | *25 715* | | |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 3 1/2 | 4.000 |
| ... | ... | 1900 | 2000 | 2300 | ... | ... | ... | ... | 2000 | 2100 | 2400 | ... | 2000 | 2100 | 2400 | 4 | 4.500 |
| ... | ... | *9711* | *11 653* | *14 567* | ... | ... | ... | ... | *11 800* | *14 160* | *17 700* | ... | *14 978* | *17 974* | *22 467* | | |
| ... | ... | 1900 | 2000 | 2300 | ... | ... | ... | ... | 2000 | 2100 | 2400 | ... | 2000 | 2100 | 2400 | 5 | 5.563 |
| ... | ... | *8988* | *10 786* | *13 482* | ... | ... | ... | ... | *11 235* | *13 482* | *16 852* | ... | *13 482* | *16 178* | *20 223* | | |
| ... | ... | 1900 | 2000 | 2300 | ... | ... | ... | ... | 2000 | 2100 | 2400 | ... | 2000 | 2100 | 2400 | 6 | 6.625 |
| ... | ... | *8483* | *10 180* | *12 725* | ... | ... | ... | ... | *10 838* | *13 005* | *16 257* | ... | *13 042* | *15 650* | *19 563* | | |
| 2800 | 2800 | 2800 | 2800 | 2800 | 2800 | 2800 | 2800 | ... | 2800 | 2800 | 2800 | ... | 2800 | 2800 | 2800 | 8 | 8.625 |
| *8850* | *10 313* | *8325* | *9990* | *12 487* | *9414* | *11 297* | *14 122* | ... | *10 504* | *12 605* | *15 756* | ... | *10 145* | *12 174* | *15 218* | | |
| 2800 | 2800 | 2800 | 2800 | 2800 | 2800 | 2800 | 2800 | ... | 2800 | 2800 | 2800 | ... | ... | ... | ... | 10 | 10.750 |
| *9015* | *10 019* | *7842* | *9410* | *11 763* | *9302* | *11 163* | *13 953* | ... | *10 465* | *12 558* | *15 698* | ... | ... | ... | ... | | |
| 2800 | 2800 | 2800 | 2800 | 2800 | 2800 | 2800 | 2800 | ... | 2800 | 2800 | 2800 | ... | ... | ... | ... | 12 | 12.750 |
| *7934* | *9918* | *7843* | *9412* | *11 765* | *8824* | *10 588* | *13 235* | ... | *10 290* | *12 348* | *15 435* | ... | ... | ... | ... | | |
| 2800 | 2800 | 2700 | 2800 | 2800 | 2800 | 2800 | 2800 | ... | 2800 | 2800 | 2800 | ... | ... | ... | ... | 14 O.D. | 14.000 |
| *8031* | *10 039* | *7586* | *9103* | *11 379* | *8929* | *10 714* | *13 393* | ... | *10 043* | *12 051* | *15 064* | ... | ... | ... | ... | | |
| 2700 | 2800 | 2700 | 2800 | 2800 | 2800 | 2800 | 2800 | ... | 2800 | 2800 | 2800 | ... | ... | ... | ... | 16 O.D. | 16.000 |
| *7732* | *9666* | *7613* | *9135* | *11 419* | *8981* | *10 777* | *13 472* | ... | *9763* | *11 715* | *14 644* | ... | ... | ... | ... | | |
| 2700 | 2800 | 2700 | 2800 | 2800 | 2800 | 2800 | 2800 | ... | 2800 | 2800 | 2800 | ... | ... | ... | ... | 18 O.D. | 18.000 |
| *7707* | *9633* | *7461* | *8953* | *11 192* | *8678* | *10 413* | *13 017* | ... | *9722* | *11 667* | *14 583* | ... | ... | ... | ... | | |
| 2600 | 2800 | 2700 | 2800 | 2800 | 2800 | 2800 | 2800 | ... | 2800 | 2800 | 2800 | ... | ... | ... | ... | 20 O.D. | 20.000 |
| *7500* | *9375* | *7500* | *9000* | *11 250* | *8750* | *10 500* | *13 125* | ... | *9685* | *11 622* | *14 528* | ... | ... | ... | ... | | |
| 2600 | 2800 | 2600 | 2800 | 2800 | 2800 | 2800 | 2800 | ... | 2800 | 2800 | 2800 | ... | ... | ... | ... | 24 O.D. | 24.000 |
| *7500* | *9375* | *7292* | *8750* | *10 937* | *8592* | *10 310* | *12 887* | ... | *9633* | *11 560* | *14 450* | ... | ... | ... | ... | | |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 30 O.D. | 30.000 |

2. Test pressures for sizes 8 in. and larger are calculated by Barlow's Formula and based on nominal wall thicknesses and fiber stresses equal to 60 per cent of the minimum specified yield points. The pressures are listed to the nearest 50 lb. for pressure under 1000 psi. and the nearest 100 lb. for pressures over 1000 psi., with a maximum listed pressure of 2800 psi., except 20 in. O. D. Schedule 30, Grade A; 18 in. O.D. Schedule 60, Grade A; and 12 in. Schedule 80, Grade B, which were adjusted to maintain logical sequence in the table. The maximum test pressure of 2800 psi. is based on a study of mill pump capacities. Test pressures for sizes under 8 in. are adjusted pressures.

3. Maximum test pressures for sizes 1 in. and under are limited to 1000 psi. by pump capacities, mechanical difficulties, and safety hazards encountered in testing these small sizes to higher pressures.

4. Welded pipe 2 in. nominal pipe size and larger shall be jarred while under pressure by striking with a 2-lb. hammer or its equivalent.

...YDROSTATIC TEST PRESSURES.[a]

| Schedule 100 | | | Schedule 120 | | | Schedule 140 | | | Schedule 160 | | | XX-Strong | | | Size, in. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ...W. ...de A | Grade B | Grade C | L.W. Grade A | Grade B | Grade C | L.W. Grade A | Grade B | Grade C | *B.W. L.W. Grade A | Grade B | Grade C | *B.W. L.W. Grade A | Grade B | Grade C | |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1/8 to 1 |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | 1800 | 1900 | 2200 | 1800 | 1900 | 2200 | 1 1/4 to 3 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | 2000 | 2100 | 2400 | 2000 | 2100 | 2400 | 3 1/2 to 6 |
| 2800 | 2800 | 2800 | 2800 | 2800 | 2800 | 2800 | 2800 | 2800 | 2800 | 2800 | 2800 | 2800 | 2800 | 2800 | 8 to 16 |
| 2700 | 2700 | 2800 | 2700 | 2800 | 2800 | 2800 | 2800 | 2800 | 2800 | 2800 | 2800 | .. | .. | .. | 18 to 30 |

TABLE III.—ALTERNATE TABLE (STREAMLINED) OF HYDROSTATIC TEST PRESSURES.

| Size, in. | Schedule 10 Grade B | Schedule 20 Grade B | Schedule 30 Grade B | Schedule 40 Grade B | Schedule 60 Grade B | Schedule 80 Grade B | Schedule 100 Grade B | Schedule 120 Grade B | Schedule 140 Grade B | Schedule 160 Grade B | XX-Strong Grade B |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/8 to 1 | .. | .. | .. | 700 | .. | 850 | .. | .. | .. | 1000 | 1000 |
| 1 1/4 to 3 | .. | .. | .. | 1100 | .. | 1600 | .. | .. | .. | 1900 | 1900 |
| 3 1/2 to 6 | ... | ... | ... | 1300 | ... | 1800 | ... | ... | ... | 2100 | 2100 |
| 8 to 16 | 700 | 900 | 1100 | 1400 | 1900 | 2300 | 2800 | 2800 | 2800 | 2800 | 2800 |
| 18 to 30 | 500 | 700 | 950 | 1200 | 1700 | 2200 | 2700 | 2800 | 2800 | 2800 | 2800 |

equipment. In sizes up to 1 in., inclusive, the difficulty encountered in holding small sized pipe between the pump heads during testing governs largely maximum pressure for which equipment is suitable. Test pressures for sizes from 1 1/4 to 6 in., inclusive, were selected so they fall into logical sequence between the 1/8 to 1-in. group, and the 8 in. and over group. On the 8-in. size and larger, the test pressures are based on a fixed per cent of the specified minimum yield point of the steel, except that the maximum pressure listed is 2800 psi. This was decided upon after a study of maximum capacities of mill testing equipment for given size ranges. Provisions are being proposed in certain of the specifications so that provided the mill has the necessary testing capacity the pipe will be tested to 1 1/2 times the working pressure.

The bursting pressures were listed in Table I as a matter of comparison and to show that a scale of test pressures in definite relation to bursting strength is impractical, especially in the very small and in the very large sizes. At the time the table was drafted it was not expected that bursting pressures would be published with the test pressures. Therefore, it may be explained that the bursting pressures for Grades B and C material were calculated on the basis of the minimum tensile strengths of the steels. Grade A bursting pressures were, however, based on an average tensile strength of 50,000 psi. This was done to expedite the completion of the table by checking figures with calculated data in earlier tables, and because ultimate strengths of Grade A or low-carbon steel are usually well over the specified minimum. An ultimate strength of 50,000 psi. has been more or less common practice as a basis for bursting pressures listed in other published data.

The section responsible for developing these proposed tables hopes that the results will be of service to both Subcommittees IX and XXII and other interested bodies in eventually deciding upon rational standardized requirements for hydrostatic testing.

## Foreign Standards Recently Issued

STANDARDS ISSUED by a number of engineering and technical organizations in foreign countries are received by the Society as they are adopted or revised. Since members of the Society may be interested in knowing that such standards are available, they will be listed as received in the ASTM BULLETIN.

Recently the following standards have been received:

CANADIAN STANDARDS FOR:

General Specification for Galvanized Steel Wire Strand (B 12—1939).
Canadian Regulations for the Construction and Inspection of Boilers and Pressure Vessels (B 51—1939).
Mechanical Refrigeration Code (No. B 52—1939).
Design of C.E.S.A. Cast Lead-Pin Thread for Insulator Pins of Nominal Diameters of 1 in. and 1 3/8 in. (C 58—1939).
Reinforced Concrete Poles.

CANADIAN STANDARD:

Code for Identification of Piping Systems (No. B—1939).

BRITISH STANDARDS FOR:

Classification of Lubricating Oils (No. 210—1939).
Abrasive Papers and Cloths for General Purposes (No. 871—1939).
Abrasive Papers and Cloths for General Purposes (Technical Products) (No. 872—1939).
Definitions of Heat Insulating Terms and Methods of Determining Thermal Conductivity and Solar Reflectivity (D 874—1939).
Foamed Blastfurnace Slag for Concrete Aggregate (No. 877—1939).
Micrometers (External) (No. 870—1939).
Sizes of Road Stone and Chippings (No. 63—1939).
Standard Dimensions for Silica Basins, Crucibles, and Capsules.
Wrought Iron for General Engineering Purposes (Grades A, B, and C) (No. 51—1939).
Welded Steel Boilers for Hot Water Central Heating and Hot Water Supply (No. 855—1939).
Safety Glass for Land Transport (No. 857—1939).
"Best Yorkshire" Wrought Iron (No. 858—1939).
Cod Oil for Sulphonation Purposes (No. 868—1939).
Capillary Joints for Copper Tubes (Internal Dimensions of Sockets) (No. 864—1939).
Nomenclature, Definitions and Symbols for Welding and Cutting (No. 499—1939).
Welded Steel Boilers for Steam Central Heating (No. 854—1939).
Test Code for Fuel Fired Furnaces for Heating and Heat Treatment Purposes (No. 859—1939).
Schedule of Sizes of Metal Containers for Food Products (No. 866—1939).
Table of Approximate Comparison of Hardness Scales (No. 860—1939).
General Purpose Laboratory Thermometers (No. 593—1940).
Petri Dishes (No. 611—1940).
Rubber Gloves for Electrical Purposes (No. 697—1940).
Natural Aggregates up to 1 1/2 in. Nominal Maximum Size for Concrete for Structural Purposes, Including Roads (No. 882—1940).
Seamless Brass Tubes for General Purposes (No. 885—1930; 886—1940).
Vernier Callipers (No. 887—1940).
Slip (or Block) Gauges and Their Accessories (No. 888—1940).
The Testing of the Zinc Coating on Galvanized Wires (No. 443—1939).
Code for Comparative Commercial Tests of Coal or C ke and Appliances in Small Steam Raising Plants (No. 878—1939).
Steel Tubes for Water Well Casing (No. 879—1939).
Nomenclature of Hardwoods (including Botanical Species and Sources of Supply) (No. 881—1939).

## Rayon Scholarship Established

ANNOUNCEMENT HAS been made by the Rhode Island School of Design, Providence, R. I., William D. Fales, Head, Dept. of Textiles, of the establishment of a new scholarship making possible the introduction of a graduate course covering the rayon fields. The Atlantic Rayon Scholarship of $1200 will be awarded yearly to a senior textile student who in the opinion of the committee possesses those qualities which indicate a future ability as a textile executive. The student will be given an opportunity to supplement his school work by actual training and study in the industry itself, through a cooperative arrangement to be developed. The awarding committee will consist of a representative of the Atlantic Rayon Corp. and members of the faculty of the school.

The scholarship is to be used to finance the supplementary training of the student in the industry for a period of one year and will be given for the first time at the Commencement exercises to be held in May.

## Spectrographic Analysis Review

RECENTLY PUBLISHED by the British Non-Ferrous Metals Research Association, Euston St., London, N. W. 1, is a 24-page report on "Quantitative Spectrographic Analysis with the Microphotometer." This report, first of a series, constitutes a review of published work, covers electrodes, blackening curves of the photographic plate, interpreting density measurements, etc. There is a section summarizing in tabular form data on published procedures for analysis of aluminum, copper, lead, magnesium, nickel, tin, and zinc alloys. Copies of the publication can be obtained from the Association at two shillings, postage prepaid.

# Needed Improvements in the Cement Briquet Testing Apparatus

By Paul Cloke[1] and W. S. Evans[2]

ANYONE TESTING cement briquets will observe that in a large number of cases the briquet does not break at its smallest section as it was designed to do but will break somewhere in the enlarged portion and frequently at the point of contact with one of the grips (see Fig. 1). This breaking away from the center has been attributed largely to nonuniformity of the briquet, on the basis that the minimum section at the neck of the briquet contained more cement or sand of better grading than the larger sections above and below. However, it was noticed that in some cases the stronger briquets broke in this fashion more frequently than the weaker ones. It seemed evident, therefore, that the real cause of such failure was due to something other than lack of uniformity. It is the purpose of this research to determine what changes could be made in the present procedure to prevent such eccentric breaks.

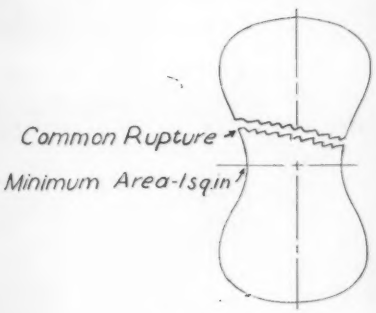



Fig. 1.

Fig. 2.

Fig. 3.

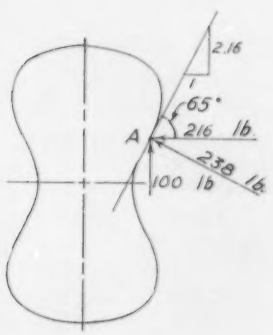



Fig. 4.

The stress distribution in the British briquet, which is practically the same as the United States standard, has been determined by Coker[3] and reported, in part, as follows:

"As will readily be observed, the distinctive feature of the distribution in this case is an extremely variable longitudinal tension *P* across the section accompanied by a variable cross-stress *Q* of considerable magnitude in the transverse direction. In this British form, for example, with a load giving a mean average stress of 500 psi., the highest value of *P* at the outer contour is 870 psi., or 1.74 times the value of the mean stress, while it sinks to 405 psi. at the center, or slightly more than 80 per cent of the mean average value. In addition to this stress there is a cross-stress *Q* which rises rapidly from a zero value at the contour to a value of about 235 psi. for the central six-tenths of the cross-section, so that the manner of loading and the form of the section call into play a cross stress of 47 per cent of the mean average stress due to the pull. It is therefore seen that a member of this form is certainly not in pure tension, and the isochromatic bands which are observed on the model indicate this quite clearly. These results are applicable to American and Canadian Standards, since these forms are practically the same as the British Standard."

The same author states that, according to its elastic properties, the cement briquet does not conform entirely to the transparent briquet but that any change made on the basis of the transparent or bakelite briquet will be more than satisfactory for the cement briquet, as ordinarily tested.

With the work of Coker as a guide, the principles of

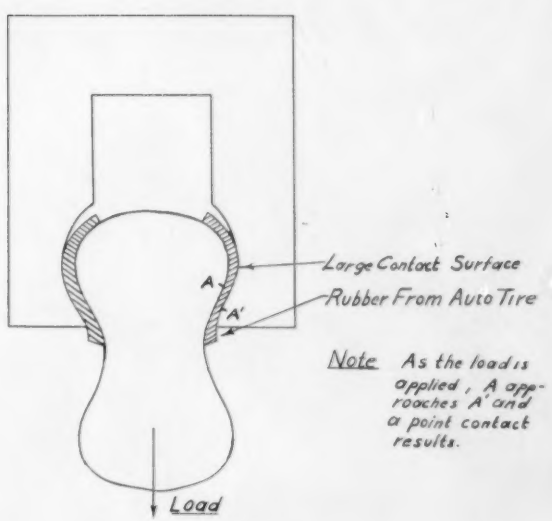

A
A'
Large Contact Surface
Rubber From Auto Tire
Note As the load is applied, A approaches A' and a point contact results.
Load

Fig. 5.

[1] Dean, College of Technology; Director, Maine Technology Experiment Station; and Professor of Electrical Engineering, University of Maine, Orono, Me.

[2] Professor of Civil Engineering, and Head, Department of Civil Engineering, University of Maine, Orono, Me.

[3] E. G. Coker and L. N. G. Filon, "A Treatise on Photo-Elasticity," pp. 578–581, Cambridge University Press (1931).

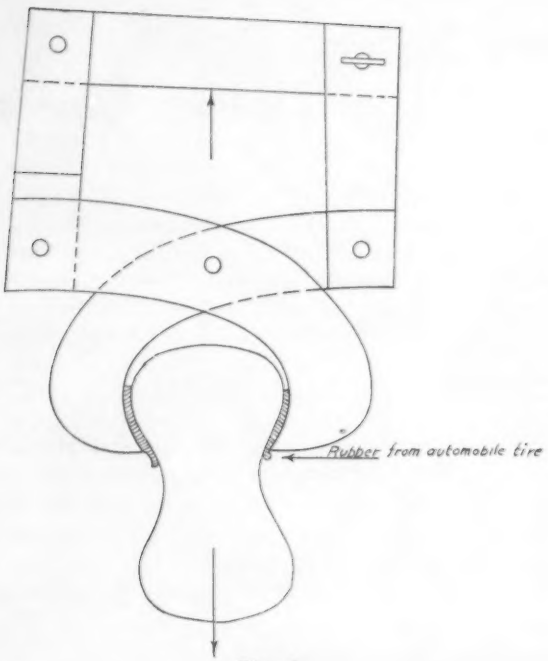



Fig. 6.

photoelasticity offered a means of studying changes in the form of specimen and changes in the present apparatus which would produce satisfactory test results.

### Experiments Performed

A full size bakelite model of a standard cement briquet was placed in a photoelastic polariscope and subjected to a load of 400 psi., using the A.S.T.M. standard grips. Figure 2, obtained without the quarter-wave plates, shows prominent dark areas over which the principal stresses were vertical and horizontal. It should be noted that over most of the center portion the $P$ stress is vertical.

With quarter-wave plates inserted, Fig. 3 resulted. The dark bands, isochromatics, indicate areas of equal shearing stress or areas in which the difference between the principal stresses $(P\text{-}Q)$ is constant. Since difference between $(P\text{-}Q)$'s for any two adjacent dark areas is 280 psi. and since at the boundary either $P$ or $Q$ is zero and $P\text{-}Q = P$ or $Q$, some realization of the magnitude of the stress in the vicinity of the roller bearing may be obtained directly.

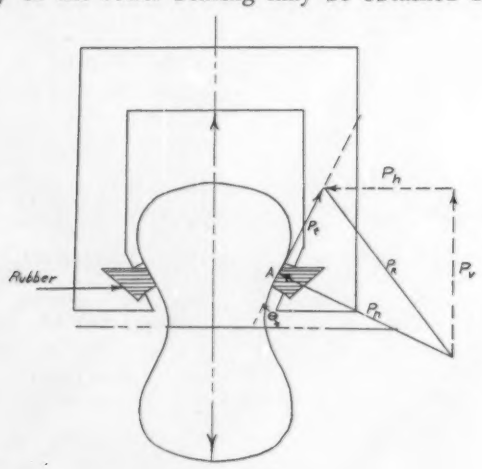



Fig. 7.

There are fourteen isochromatic bands radiating from the point of bearing. This indicates stresses of approximately 4000 psi. at these points.

Mathematical analysis of conditions at the point of contact between grip and model will clearly indicate the cause for such high stresses, see Fig. 4.

A tangent to the briquet at the point of contact makes an angle of about 65 deg. with the horizontal. Since the briquet and grip contact by means of a roller, the external forces acting on the briquet are always normal to the surface. It can readily be seen that any vertical force must be accompanied by a force normal to the surface of more than twice that amount and by a horizontal force slightly less than the normal. It then appears that the roller bearing is the worst type of bearing which it would be possible to design. A grip was made similar to that shown in Fig. 5. This grip was a great improvement over the standard grip, especially under light loads, but with the type of rubber bearing used, the higher loads caused the metal in the grip to penetrate the rubber and then, according to the photoelastic image, conditions were very nearly the same as with the standard. Next, a grip similar to that shown in Fig. 6 was designed and made. This showed no worthwhile improvements. The following analysis will indicate that probably the best type of grip should have a rubber bearing surface hard enough so that

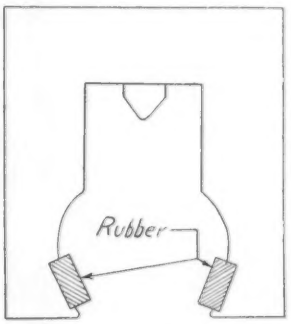



Fig. 8.

even at the maximum load the effect of the metal will not be felt on the specimen and yet soft enough to develop a high coefficient of friction and to cause an even distribution of pressure.

As a load is applied to the briquet in Fig. 7, the rubber bearing surfaces are deformed and point $A$ moves vertically downward. A force $P_n$ will result, also a force $P_t$ depending upon the flexibility of the rubber and the coefficient of friction between the rubber and concrete. Any coefficient of friction will produce results better than those produced by the roller bearing. If the proper kind of rubber is used so that the shearing deformation due to $P_t$ equals $\frac{1}{2}P_n$, then the following relation of forces will exist, providing the coefficient of friction is 0.5 or more.

Assume $\theta = 65$ deg. Then from the sum of the vertical forces

$$P_v = 0.423P_n + 0.906P_t = 0.876P_n \text{ since } P_t = \tfrac{1}{2}P_n$$

From the sum of the horizontal forces,

$$P_h = 0.906P_n - 0.423P_t = 0.694P_n$$

$$P_h = 0.8P_v$$

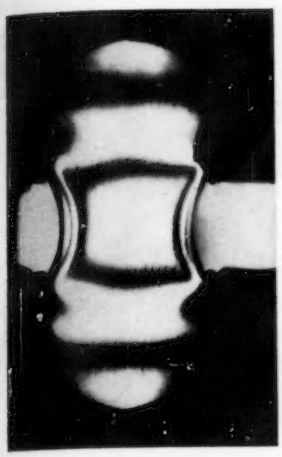


Fig. 9.

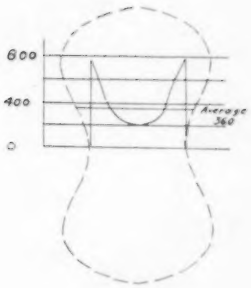



Fig. 10.

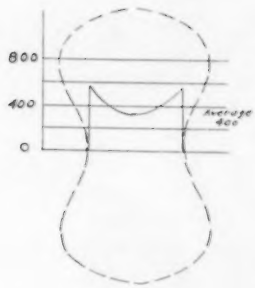



Fig. 11.

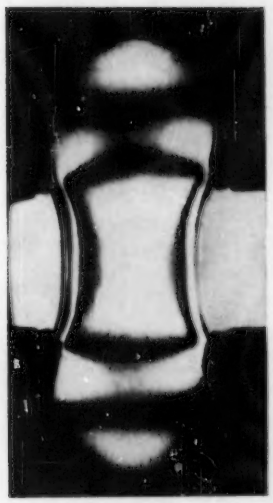


Fig. 12.

The corresponding values from Fig. 4 are

$$P_h = 2.38P_v$$

Hence it may be seen that due to a load of 500 lb., the briquet will be subjected to a transverse load of 200 lb. as compared to 540 lb. for the present A.S.T.M. standard. The grip shown in Fig. 5 was modified as shown in Fig. 8. Through the courtesy of the Goodyear Rubber Co., several samples of rubber were obtained which varied in hardness from soft to fairly hard. Various samples were tried until one was found which eliminated any indication of stress concentration on the bearing surface. This is shown in Fig. 9.

The next problem was to smooth out the stress across the neck of the briquet. The distribution of vertical stress across the neck of the briquet using the standard grip (Fig. 3) is shown in Fig. 10, while the distribution for the modified form of grip (Fig. 9) is shown in Fig. 11. There is little practical difference; however the rubber grip has caused some change for the better. Figure 10 shows that, for the standard grip, the maximum stress at the edge is twice the average stress on a section at the center, while Fig. 11 shows that, for the rubber grip, the maximum is about one and one-half times the average. These variations are somewhat greater than was expected from Coker's determination for the British briquet. They indicate that the tensile strength of portland-cement mortar is much greater than test results obtained from standard briquets indicate.

Following these findings, two bakelite models were made similar to the standard except that one had a $^1/_2$-in. uniform cross-section in the center, while the other had an extra 1 in. in the center. The photoelastic results are shown in Figs. 12 and 13, while the variations in stress across the center are plotted in Figs. 14 and 15.

Figure 14 shows that the added $^1/_2$-in. length caused some improvement in stress distribution. Figure 15 shows that when 1 in. is added, nearly perfect results are obtained. Because of the elastic properties peculiar to portland-cement mortar, the distribution of stress in the cement briquet is even more uniform than is indicated by the bakelite model. Figure 16 shows that, in the central portion of the briquet, there is a large area over which the principal stresses are vertical and horizontal. Since there can be no horizontal stress at the boundary, there can be

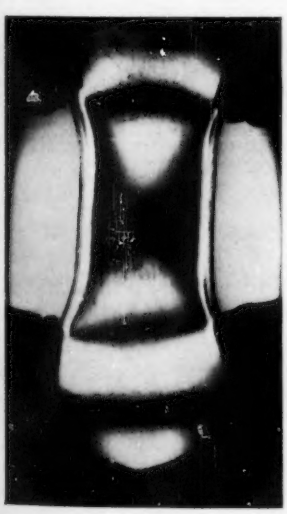


Fig. 13.

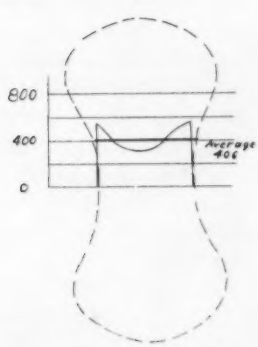



Fig. 14.

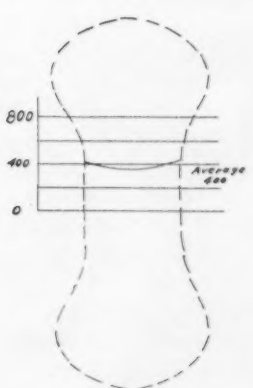



Fig. 15.

Fig. 16.

no horizontal component within this area and the stress is pure tension. Thus, the results obtained by using this form of test specimen and a type of grip similar to that shown in Fig. 8, will truthfully indicate the tensile strength of portland-cement mortar.

In carrying out these experiments, it was noted that whereas the roller bearing permitted some adjustment of the specimen as tension was applied, the rubber bearing did not. Because of this lack of flexibility, in any machine constructed to make use of the findings herein recorded, the grip should be held securely instead of supported on a pivot. The rubber would then offer sufficient flexibility to permit the specimen to come to an upright position without causing uneven stresses.

*Acknowledgment:*

The authors gratefully acknowledge the services rendered by Dr. Karl D. Larsen, Assistant Professor of Physics, in assisting with this investigation.

## New Cement Specifications Proposed; Extensive Symposium Held

An extensive Symposium on Cement Specifications and Additions to Portland Cement featured the two-day session of Committee C-1 on Cement held at the National Bureau of Standards, Washington, D. C., on March 18 and 19. Of special interest was the decision of the committee to refer to letter ballot proposed new specifications for five types of portland cement. The meetings were well attended by members of the committee and visitors.

Plans for the symposium and the development of papers had been under way for several months. As a result of the cooperative work of the members, eighteen valuable papers were presented. All but one of those papers had been distributed to the C-1 members prior to the meeting and, on that account, interesting discussions of the papers were presented.

The symposium papers were not intended for publication, but because of requests for additional copies, arrangements are being made to provide a limited number of extra copies at the cost of reproduction. (Inquiries about these copies should be sent to Mr. D. Wolochow, National Research Council of Canada, Ottawa, Ontario, Canada.)

The second day of the meeting was particularly interesting. For more than a year a special subcommittee of nonproducer members had been studying the question of what should be the number and kind of specifications to meet the needs of users of portland cement. Several months ago that subcommittee presented to Committee C-1, for consideration, proposed tentative specifications for five types of portland cement. These specifications were published as information in the January ASTM Bulletin to encourage discussion. Having considered the recently received comments, an enlarged subcommittee submitted revised specifications at the March 19 meeting, recommending that they be approved for presentation to the Society. The proposed specifications, with certain changes made at the meeting, were approved by Committee C-1, subject to letter ballot of the committee, for submission to the Society in June as a tentative standard.

The Working Committee on Methods of Chemical Analysis described the work now being done on methods of determining certain additions in cement. The committee approved the subcommittee's recommendation that Sections 1 to 9 of the methods of chemical analysis be presented to the Society for adoption as standard.

The Working Committee on Plastic Mortar Tests reported the results of an extensive series of tests on 2-in. cubes. Six laboratories had participated, using six cements and employing six mixes. The work had also included studies of "relative water capacity" of the cements and the use of vibration in molding cubes.

The Working Committee on Volume Change and Soundness presented an extensive report of the results of studies of certain variations in types of test specimens and in methods of conducting the autoclave test. Thirty laboratories participated in the tests, using 221 cements. A revised method for determining the soundness of cements by the autoclave was approved by Committee C-1, subject to letter ballot for submission to the Society as a new tentative standard.

Other subcommittees reported progress on their problems and discussed some of the recently obtained data. The Cement Reference Laboratory discussed its recent work, progress of the tests on cement containing a certain addition, and the results of tests on Comparative Test Sample No. 3.

The series of meetings were directed by P. H. Bates, *Chairman*, National Bureau of Standards, with L. W. Walters, *Secretary*, Erie Railroad, and J. R. Dwyer, Technical Assistant.

## Committee B-1 on Copper and Copper-Alloy Wires for Electrical Conductors

At the well-attended meetings of Committee B-1 held in New York City on April 9, decisions were reached on a number of important points. The committee plans to recommend a number of detailed revisions in the specifications covering soft rectangular and square copper wire for electrical conductors (B 48), including a reduction in the sizes of recommended packages for the very small sizes of wire, a clarification of the prescribed shape and tolerances for wire having half-round edges, and a modification of the method of selecting samples and of the requirements for retests. It will be recommended that these specifications retain their tentative status for another year.

The committee has instructed its subgroup in charge to develop a new tentative standard covering cable of other than concentric constructions. It was also voted to recommend the adoption as standard of the specifications for figure 9 deep-section grooved and figure 8 copper trolley wire for industrial haulage.

Some inconsistencies in the allowable tolerances prescribed for areas and diameters of wire in various A.S.T.M. standards are being scrutinized by the committee, and it is possible that changes in some of the specifications will be recommended.

# Adaptor for Hardness Testing Machine

By Robert H. Heyer[1]

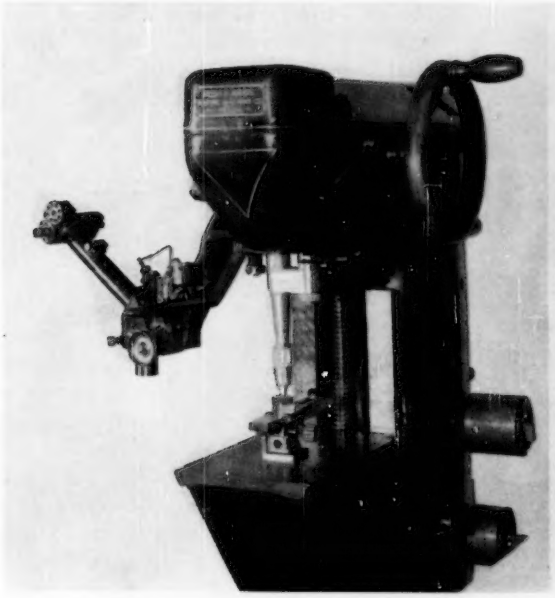


Fig. 1.

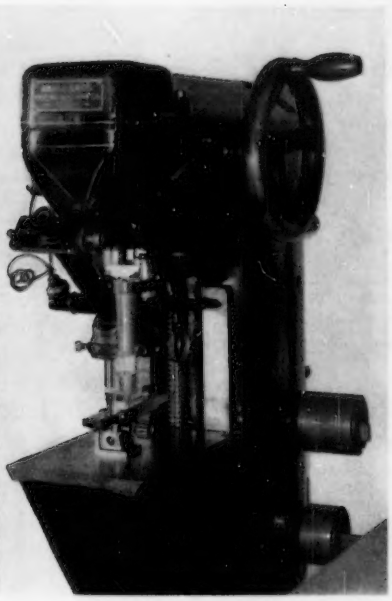


Fig. 2.

LIGHT GAGE sheets and small irregular objects offer serious handicaps in making hardness determinations. The usual forms of indentors and the more commonly used loads are often too large. Inasmuch as the Vickers hardness testing machine employs a small diamond penetrator and can use very light loads, it is possible by suitably mounting the specimen, in plastics or otherwise, to carry out such measurements in laboratory work. The methods hereinafter described expedite the use of the Vickers hardness tester, and for this reason are presented as of interest to testing engineers.

Whenever large numbers of Vickers impressions are to be made, the inherently slow operation of this instrument becomes a serious handicap. One of the contributing factors has been eliminated, namely, the necessity for raising the stage a distance of about 5 in. for making impressions and then lowering it an equal distance in order to measure them by means of the filar microscope. This has been accomplished by means of an attachment which changes the working level of the penetrator to the focal plane of the microscope. Figures 1 and 2 show the penetrator in position for making an impression and in the open position which permits measurement of the impression with the microscope in place. The sample holder shown here permits movement in one direction so that several consecutive impressions may be made on a single sample, after which each impression may readily be brought into focus under the microscope. Obviously an adjustable vise of this type also contributes to increased speed of operation.

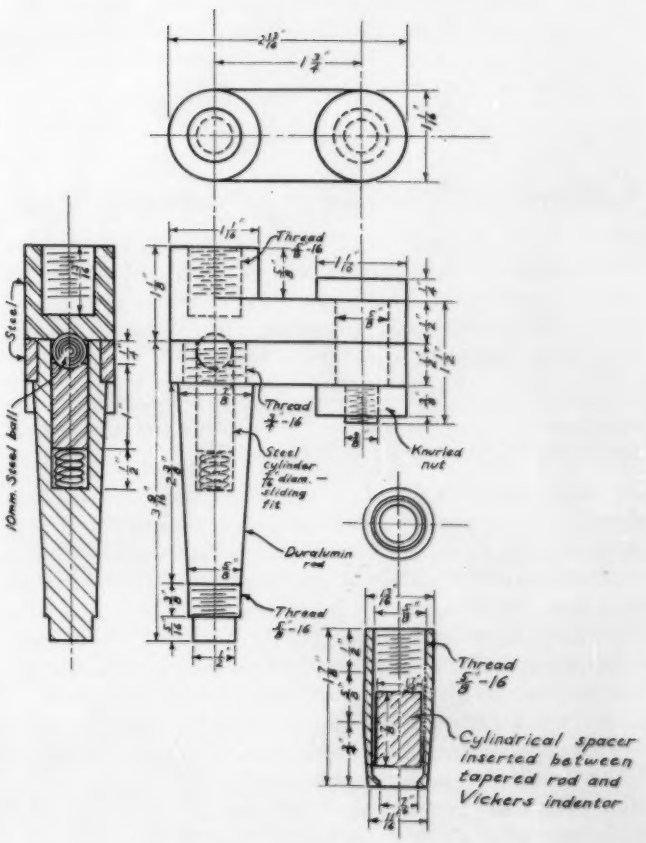



Fig. 3.

[1] Junior Metallurgist, The American Rolling Mill Co., Middletown, Ohio.

Figure 3 shows the penetrator attachment. This attachment was designed to accommodate a special adaptor for Rockwell penetrators. If only Vickers penetrators are to be used, the tapered portion of the long vertical member may be made $3^1/_4$ in. instead of $2^3/_8$ in. in length. In this case the standard fitting used to attach the Vickers penetrator may be used.

It is probably desirable to use a light alloy such as duralumin in place of some of the steel parts indicated in the drawing. In any event it will be necessary to compensate for the added weight of the indentor. It will be found convenient, in principle, to determine the added weight, divide by 20, and remove this amount from the loading platform at the rear of the machine. (The loading lever arm has a ratio of 20 to 1.) Actually this is difficult to do because the parts affected are already very light. However, one can replace the aluminum disk loading platform with one which will apply a load of exactly 5 kg. to the specimen. A 250-g. slotted weight should also be made available for adding another 5 kg. to the load. The standard weights can then be used to obtain all other commonly used loads.

## Mortars for Unit Masonry

COMMITTEE C-12 on Mortars for Unit Masonry held a well-attended meeting at the National Bureau of Standards in Washington on March 22. Among the items considered by the committee was the report of a special subcommittee consisting of Messrs. Plummer, *Chairman*, Parsons, and Stauffer on the Primer on mortar. The subcommittee submitted a complete redrafting of this document and asked for comment and criticism. Dr. F. O. Anderegg reported in some detail the results obtained by him in the application of certain new techniques to the testing of mortar. Dr. Anderegg stated that he was preparing a paper which described these methods in detail and he urged that the committee members and others interested experiment with these methods.

Mr. Rapp presented complete methods of test and specification for mortar for glass block. Since neither Mr. Plummer's nor Mr. Rapp's report had been made available to the committee before the meeting, further consideration and action were deferred.

## Rubber-Like Materials in Committee's Scope

AT THE recent meetings of the Executive Committee, favorable action was taken on the request of Committee D-11 on Rubber Products that its scope be expanded to include rubber-like materials. The new statement is to read as follows:

"The formulation of specifications and methods of test for products made from rubber or rubber-like materials including research investigations concerning the properties of these materials."

Committee D-11 felt this would be desirable because there are a number of synthetic materials which are not properly called "rubber" but which are coming to be used more extensively in the rubber industry. Many of these materials are being made into products which formerly were made from rubber compounds, but which now have little or no real rubber at all. These products in general are manufactured by the rubber companies and are properly considered a part of the industry's output.

This expanded scope will also cover certain other rubber-like materials which are coming into use. It is expected that eventually a good many of the materials classified under the general term "rubber-like" will be studied by the committee in its extensive standardization and research program.

## Pilot Tests in Non-Ferrous Corrosion Tests

IN A STATEMENT on the activities of Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys appearing on page 43 of the March BULLETIN it was indicated that in the work on total immersion tests, five laboratories were to run tests of a number of non-ferrous metals and alloys in three solutions, the tests to be made in aerated and nonaerated solutions at 35 C.

Owing to the brevity of the statement, it led to the erroneous impression that the entire program was to be undertaken at once. Actually, the committee plans first to conduct pilot tests, using only commercial copper, to determine whether the selected test procedures are satisfactorily reproducible. If the procedures appear to be satisfactory, the committee plans to test the various metals in one or more of the solutions. However, it is not the committee's intention to test all five metals in all three solutions.

## Meeting of Technology Library Group

THE THIRTY-SECOND Annual Conference of the Special Libraries Association will be held at the Claypool Hotel, Indianapolis, Ind., June 3 to 6. One of the active divisions is the Science-Technology group, with a membership of approximately 700. Ross C. Cibella, Librarian of Hall Laboratories, Inc., is chairman of the group which includes engineering and chemical librarians, abstractors, bibliographers, and literature searchers of various manufacturing and technical companies.

E. J. Crane, Editor, *Chemical Abstracts*, is to be the principal speaker at the group conference. His address, to be given at 2 p.m. on June 4, will cover the abstracting of articles from the scientific viewpoint.

## Highway Research Board Publication

ANNOUNCEMENT HAS been made of the publication of Volume 19, Proceedings, of the Highway Research Board. There are a large number of papers and reports by outstanding authorities dealing with highway technology—including finance and economics, materials and construction, maintenance, traffic, and safety. Some fifteen items pertain to design; the intensive interest in work on soils is indicated by the inclusion of eleven papers dealing with soils and five covering soil stabilization practices. Copies of this publication in cloth binding can be obtained from the Board, 2101 Constitution Ave., Washington, D. C., at $2.25 each.

## Meeting on Manufactured Masonry Units

At a meeting held in Washington, D. C., on March 21, Committee C-15 on Manufactured Masonry Units continued the discussion of the properties of masonry units begun at the symposium held in December, 1939. Special attention was paid to the subject of research on the durability of masonry units. Papers describing the research at the National Bureau of Standards and Alfred University were presented. The indications of incomplete data obtained at the Bureau are that the selection of some clay building brick may be made with greater certainty by a slight modification of the method for determining values of the saturation coefficient. The research at Alfred University was concerned chiefly with products made in the state of New York. The data indicated that some of these did not show as close a relation between the physical properties usually determined in separate tests and resistance to thawing as the majority of brick manufactured in the United States. New methods for judging the qualities of these products were discussed.

The committee also received a report on the investigation of paving brick being conducted jointly by the Ohio State Highway Commission and the Public Works Administration. Although the data are still too incomplete for drawing definite conclusions, the preliminary results seem to justify the belief that the investigation will provide a better basis for the development of standards for paving brick.

A progress report of the work of the Joint Committee on Efflorescence was heard and discussed.

The only actions of the committee affecting standards are a proposed editorial revision of the specifications for clay building brick (C 62 – 39 T) and a recommendation to advance to standard the present tentative standard for solid load-bearing concrete units (C 145 – 39 T).

D. E. Parsons, National Bureau of Standards, Chairman of Committee C-15, presided, with J. W. Whittemore, Secretary.

## Committee on Magnetic Properties

Discussion of a number of its standardization and research activities took place at the meeting of Committee A-6 on Magnetic Properties held at A.S.T.M. Headquarters on March 25.

The committee received reports of progress on two round-robin tests which are under way for the purpose of developing the necessary data for preparing specifications covering (1) methods of testing magnetic materials under combined a-c. and d-c. magnetization and (2) tests of a-c. permeability and core loss with small Epstein samples.

Revisions of the method for measuring interlamination resistance (A 34–39 T) were approved to provide for the use of 40 strips in the specimen instead of 750 g. and also that the specimen shall be preloaded at 500 psi. before making the resistance measurement.

Thomas Spooner, Westinghouse Electric and Mfg. Co., is chairman of Committee A-6, and R. L. Sanford, National Bureau of Standards, is secretary.

## Committee D-20 on Plastics

At the series of meetings held by Committee D-20 on Plastics and five of its subcommittees, at the Wardman Park Hotel, Washington, D. C., on February 28 and 29, a number of standardization and research projects were considered. In the work on strength properties considerable progress is reported with the design of a tension test specimen for thermoplastics. The subcommittee concerned with hardness properties has its work well under way on a proposed method for measuring deformation under load and the project which it is hoped eventually will result in a standardized method for measuring mar resistance is also being advanced.

Acting on a recommendation of the subcommittee on thermal properties, Committee D-20 plans to recommend, subject to letter ballot, a proposed new A.S.T.M. method covering tests for flammability of plastics which applies to sheet material up to and including 0.030-in. thick stock. In connection with the work on optical properties, standardized procedures for measuring surface irregularities of transparent plastics are being developed.

The committee has a number of test projects and cooperative research investigations under way. At the meeting there was a very interesting display of specimens to be used in the round-robin tests for resistance to light. The meetings were under the direction of W. E. Emley, *Chairman*, National Bureau of Standards, and W. A. Evans, *Secretary*, Bell Telephone Laboratories, Inc.

## Arc Welding Electrode Specifications Approved

By action of Committee E-10 on Standards the Society has approved for publication as tentative, specifications for iron and steel arc welding electrodes. These are under the joint auspices of the American Welding Society and A.S.T.M., having been developed by the A.W.S. Filler Metal Specifications Committee headed by J. H. Deppeler, Metal and Thermit Corp., and in Committee A-1 on Steel by Subcommittee XXI on Steel for Welding headed by N. L. Mochel, Westinghouse Electric and Manufacturing Co. These new specifications, which have the designation A 233 – 40 T, replace immediately the Tentative Specifications for Iron and Steel Filler Metal (Arc-Welding Electrodes and Gas-Welding Rods) (A 205 – 37 T). The superseded specifications covered material for both arc welding and gas welding procedures and the new ones apply just to the arc method. It is the intention of the committee concerned to develop additional specifications for other types of welding electrodes and filler metal.

The new specifications cover electrodes for the welding of carbon and low-alloy steels of weldable quality. They are classified on the basis of usability and ultimate tensile strength of all-weld-metal specimens in the stress relieved condition. There are some 14 different electrode classifications.

Each member of the Society can obtain a copy of this specification on request to A.S.T.M. Headquarters. Extra copies are available at the regular scale of 25 cents each; for 10 to 24 copies, 20 cents each; 25 to 99 copies, 17½ cents each, with quotations given on larger quantities.

ASTM Bulletin

MAY 1940

NO. 104

TWO-SIXTY
SOUTH BROAD ST.
PHILADELPHIA, PENNA.

## Time Expended and Results

One wonders at times whether in the course of developing a proposed specification or test method the chairmen or members of a particular section or subcommittee are not themselves being subjected to some kind of fatigue test, or determination of endurance limit. Not infrequently before a proposal can go to a standing committee vote there may be some four to six drafts, half a dozen meetings of a subcommittee, and perhaps four or five long-drawn-out meetings of sections. Fortunately for the Society and accordingly for industrial progress in the field of materials, committee members and officers seem to have relatively high endurance limits.

In considering time and effort expended on a standard which eventually may bear the A.S.T.M. seal, we should ask whether enough effort is expended in promulgating the use of a standard. While considerable attention is now given to this, it is well to keep constantly in the forefront the basic fact that a specification or test merely published in black ink on white paper is not doing anyone much good unless it does find application.

The Society specifications and tests are being used more and more widely. The number of inquiries about standards and about technical matters is increasing which indicates a healthy condition, but all should bear in mind that the value of a specification or test is not measured by the energy expended in getting it accepted as an A.S.T.M. item, but by its use in industry and related fields.

## Preprints and Discussion

The Society's policy of preprinting in advance of the annual meeting the *reports* of standing committees is an essential part of its standardization development work. All interested members of the Society must have full knowledge of the various committee recommendations which will come up for action. This knowledge is necessary for intelligent voting; it is desirable from the members' standpoint so that they will be in touch with important developments which may affect them or their company's interests.

The primary purpose of preprinting as many as possible of the *technical papers* being given at the meeting is to stimulate discussion and comment. There is probably no other group which concentrates so much effort on this task of getting material in type or duplicating it and distributing papers before the meeting. Not only does each A.S.T.M. member have the privilege of getting available preprints but the items are mailed to many individuals and technologists who may not be members but are known to have a definite interest in a particular subject and may be in a position to offer helpful comments.

Much of the value of the Society's *Proceedings* and its other technical publications is attributed to the discussion published. Frequently, this adds additional data and information. It may call for very careful interpretation of an author's data; in some cases may take direct issue with his conclusions, thus insuring a careful consideration of the facts.

Each discusser is given an opportunity to review his comments prior to publication so that he can revise it or even withdraw it entirely as he sees fit. Progress in the field of materials is stimulated by the interchange of thoughts. The basis of much of the Society's success in promoting knowledge of materials depends on the fact that our meetings are a forum for *discussion* on the subject of materials and everyone is encouraged to take part in such discussion.

## Charges for Right to Reprint A.S.T.M. Standards Adopted as New Policy

The Executive Committee of the Society has recently established the policy of making a charge for the right to reprint the copyrighted A.S.T.M. standards and tentative standards. For many years no charge for this right has been made. In recent years many organizations have for excellent reasons found it desirable, in their utilization of A.S.T.M. standards, to reprint them in their own type format for distribution instead of purchasing them from the Society, which in general is preferred and is usually done. Thus the Society is deprived of a needed source of income from sales of publications, to an extent which has come to be quite considerable with the rapidly expanding use of A.S.T.M. standards. It is equitable that the Society should be reimbursed for this privilege, inasmuch as all income from publication sales is applied to the operations of the Society which benefit not only its members but industry generally.

Accordingly, a scale of charges for the right to reprint standards and tentative standards has been adopted, the charges depending upon the number of standards and the number of copies to be printed. Anyone desiring to reprint one or more A.S.T.M. standards or tentative standards should communicate with the Secretary-Treasurer of the Society for the required permission, whereupon the charges applicable to each case will be quoted.

The charges apply to all reprinting in full, either as separates or in pamphlet form, or as part of a book. No charge is made for reprinting excerpts from standards, although permission for excerpting should be obtained. It is required that suitable acknowledgment be made to the Society in all cases.

# Eighteen New Sustaining Members as of April 16

## Total Reaches Seventy-two

Since the list of latest Sustaining Members was published in the March Bulletin, 18 new ones have been received up to April 16, bringing the total in this class to 72. Short notes concerning the new members are given below. At the close of 1938 only twelve organizations had subscribed to this class of membership, the annual dues for which are $100. During 1939, 17 were added, bringing the total to 29; so far this year 43 others have become Sustaining Members.

The very encouraging growth in the list is significant and is indicative of the willingness of many organizations which benefit considerably from the Society's extensive standardization and research programs to support the work financially in a manner which may be more nearly commensurate with the inherent advantages of the work to them. The Society in all phases of its work endeavors earnestly to make its activities of utmost value to all branches of industry concerned with the field of engineering materials, and obviously with so many materials fields expanding rapidly the Society's work is likewise being extended.

As announced previously Sustaining Members receive *all* publications issued by the Society, which in addition to so-called regular publications—Book of Standards, *Proceedings*, Bulletin, Year Book, etc.—include all technical publications, symposiums, etc., a number of which are available only on purchase. They may also procure an extra set of the Book of Standards.

### *New Sustaining Members*

Wellington Sears Co., Henry S. Grew, Jr., Fabric and Testing Engineer, New York, N. Y.

This company has been concerned with A.S.T.M. work for many years and has been a company member since 1919. Mr. Grew has represented the company on Committee D-13 on Textile Materials, serving on the subcommittees on household and garment fabrics and glass fiber and its products.

Celanese Corporation of America, C. F. Beran, Vice-President, New York, N. Y.

Affiliated with the Society as a company member since 1925, this company has been particularly interested in the work of Committee D-13 on Textile Materials. Mr. Beran represents his company on the subcommittee on rayon and its products, serving as a member of the section on rayon staple and spun rayon yarn.

Hydro-Electric Power Commission of Ontario, W. P. Dobson, Chief Testing Engineer, Toronto 2, Ontario, Canada

This organization with a large technical and engineering department has been affiliated with the Society for over 25 years, its membership dating from 1913. Mr. Dobson has been connected with the work of Committee D-9 on Electrical Insulating Materials since 1923. The Commission is represented on Committee A-5 on Corrosion of Iron and Steel by T. H. Chisholm, Chemist. R. B. Young, Testing Engineer, a personal member of the Society, has been especially active in the work of Committees C-1 on Cement and C-9 on Concrete and Concrete Aggregates. He is a member of three of C-9's subcommittees and is chairman of the group in charge of the work on ready-mixed concrete. It is of interest, also, to note that Mr. Young is the new President of the American Concrete Institute.

American Smelting and Refining Co., S. J. Dickinson, Technical Adviser, Barber, N. J.

A number of technologists from this company have been active in the Society's work and the company has maintained corporate membership since 1926. F. F. Poland, Research Metallurgist, represents the company on committees B-1 on Copper and Copper-Alloy Wires for Electrical Conductors, B-2 on Non-Ferrous Metals and Alloys, B-5 on Copper and Copper Alloys, Cast and Wrought, and E-4 on Metallography. A. J. Phillips, a personal member, Superintendent of Research, is also very active on four of the "B" committees and is a member of Committees E-2 on Spectrographic Analysis and E-1 on Methods of Testing. He is chairman of the subcommittee on test methods of Committee B-5.

American Car and Foundry Co., Victor Willoughby, Vice-President, In Charge of Engineering, New York, N. Y.

Concerned especially with the Society's work in the field of ferrous metals, this company has been a member of A.S.T.M. since 1913. Mr. Willoughby has represented his company for over 15 years on the Steel Committee while J. M. Keller has served the same length of time on Committee A-3 on Cast Iron. Mr. Willoughby is also a member of Committee C-16 on Thermal Insulating Materials.

A. P. Green Fire Brick Co., R. S. Bradley, Director of Research, Mexico, Mo.

Affiliated with the Society as a company member since 1923, this company has been particularly interested in the Society's work in the field of refractories. Mr. Bradley has represented the company on Committee C-8 on Refractories for many years. He is Chairman of Subcommittee II on Research and is active on other subcommittees and sections. He represents C-8 on several sections of Committee E-1 on Methods of Testing. He is also the alternate for the American Representative in the International Committee on Refractory Materials, I.S.A. 33.

Potomac Electric Power Co., J. H. Ferry, Vice-President and Chief Engineer, Washington, D. C.

This company has been a member of the Society since 1929 having been represented during that time by Mr. Ferry. Because of the activity of A.S.T.M. in many fields of concern to the power and electric utility fields, the company is interested in a number of phases of A.S.T.M. work.

Sargent & Lundy, Inc., L. Skog, Vice-President, Chicago, Ill.

Affiliated with the Society since 1923, this company is represented on various A.S.T.M. committees, including Committee A-1 on Steel in which Mr. Skog is active, particularly in the work of the subcommittee on valves, fittings, piping and flanges for high-temperature service, serving on the sections on pipe and bolting. Andrew LeBailly, Assistant Mechanical Engineer, represents the company on Committee C-16 on Thermal Insulating Materials.

Arlington Mills, J. S. Mercer, Agent, Boston, Mass.

Since 1930 this organization has been a company member of the Society, represented by Mr. Franklin W. Hobbs, President. On acquiring Sustaining Membership, Mr. Hobbs designated Mr. Mercer as the representative in the Society. Hugh Christison, Chemist, Lawrence, Mass., formerly a personal member, represents his company on Committee D-13

on Textile Materials, serving on various sections of the subcommittee on wool and its products. C. L. Nutting serves on Committee D-12 on Soaps and Other Detergents and is chairman of the specifications subcommittee dealing with textile soaps.

American Steel and Wire Co., Flint C. Elder, Chief Metallurgist and Director of Research, Cleveland, Ohio

With its membership dating from 1900 this company will be awarded a forty-year certificate at the 1940 Annual Meeting. Concerned with the work of Committees A-1 on Steel and A-5 on Corrosion of Iron and Steel, the company is represented actively by Mr. Elder and by other technical representatives. Mr. Elder is also on Committee B-2 on Non-Ferrous Metals and Alloys. E. E. Legge, District Director of Research, a personal member of the Society, has been affiliated with the Steel Committee since 1928. Other engineering executives of the company participate in committee work including J. S. Richards, Manager, Metallurgical Dept., and L. H. Dunham, a personal member.

Taylor Forge and Pipe Works, J. Hall Taylor, President, Chicago, Ill.

As members of the Society since 1923 this company has through its President, Mr. Taylor, been very active in the work of Committee A-1 on Steel. A member of the subcommittee on steel tubing and pipe, Mr. Taylor is also an active member of the subcommittee on valves, fittings, piping and flanges for high-temperature service and serves as chairman of its section on forgings.

Pittsburgh Steel Co., Thomas G. Stitt, Chief Inspecting Engineer, Allenport, Pa.

Affiliated with the Society since 1921 this company has been represented on the Steel Committee since 1923 by Mr. Stitt who as Chairman of the important subcommittee on steel tubing and pipe has rendered outstanding service to A.S.T.M. This group has in its charge upwards of 25 widely used specifications. Mr. Stitt is also a member of the subcommittees on steel reinforcement bars, steel for welding and on the subcommittee on materials for high-temperature service and serves on the A-1 Advisory Committee. He also represents his company on Committee A-5 on Corrosion of Iron and Steel. Other executives with the company are concerned with the work of the Society and affiliated with it.

Shell Development Co., Fred D. Tuemmler, Head, Analytical Dept., Emeryville, Calif.

Because of its various activities in the field of petroleum products and lubricants, this company is naturally concerned with the work of Committee D-2 on Petroleum Products and Lubricants. E. Clifford Williams, Vice-President in Charge of Research, and S. Tjimstra, Chemical Engineer, who were personal members, have followed A.S.T.M. work and Mr. Tuemmler, designated to be the representative of this new corporate membership, serves on several of the D-2 subcommittees. The Shell organization is also represented in the Society by other divisions and technologists.

The Goodyear Tire and Rubber Co., S. A. Steere, Manager, Cotton and Fabric Division, Akron, Ohio

For over 25 years this company has been affiliated with A.S.T.M. In addition to Mr. Steere who has been a member of Committee D-13 on Textile Materials since 1923, the company is active in Committee D-11 on Rubber Products with H. E. Morse, Manager, Mechanical Goods Development, and W. W. Vogt having served for over ten years. R. P. Dinsmore is active on subcommittees and E. G. Kimmich, in addition to membership on several subcommittees, is chairman of the subcommittee on mechanical rubber hose. He is also Chairman of Section I on Classification of Rubber Motor Mountings, Technical Committee A on Automotive Rubber.

Missouri Portland Cement Co., L. A. Wagner, Chief Research Chemist, St. Louis, Mo.

Affiliated with A.S.T.M. since 1932, this company has been represented on Committee C-1 on Cement since that time. Mr. Wagner, who is Chairman of the Working Committee on Plasticity of C-1, also heads the working subcommittee on workability and plasticity of Committee C-12 on Mortars for Unit Masonry. Mr. Wagner has served as Secretary of the A.S.T.M. St. Louis District Committee since its organization in January, 1939.

Copperweld Steel Co., Leslie C. Whitney, Chief Metallurgist, Glassport, Pa.

While the new sustaining membership developed through the interest of Mr. Robert J. Frank, Vice-President in Charge of Sales, is the first affiliation of this company with the A.S.T.M. as a corporate member, various technical executives have been active in A.S.T.M. work for a number of years. Mr. Whitney is a member of Committee B-2 on Non-Ferrous Metals and Alloys and Stanton Hertz serves on Committee B-1 on Copper and Copper Alloy Wires. Rolf Selquist, Electrical Engineer, continues as a personal member, as does Mr. Hertz. The company has cooperated in research activities being carried out under Society auspices.

Sun Shipbuilding and Dry Dock Co., Robert Haig, Vice-President, Chester, Pa.

This organization has been a member of A.S.T.M. since 1920 and has been interested in many of the Society's activities in the standardization field. Mr. John Hudson represents the company on Committee A-5 on Corrosion of Iron and Steel.

American Creosoting Co., Stanley J. Buckman, Head of Research Dept., Louisville, Ky.

While this company has been affiliated with the Society through company membership since 1928, Mr. A. L. Kuehn, President, has been a member personally for 27 years, his affiliation dating from 1913. Carl G. Crawford, Vice-President, represented the company membership in the Society since 1928. Mr. Buckman, who has been designated as the new company representative, is a member of subcommittees of Committee D-7 on Timber and represents D-7 on technical committees of Committee E-1 on Methods of Testing including those concerned with the determination of water and volatility. E. B. Fulks, Consultant, is affiliated with the Society, personally, and serves on Committee D-7.

## Scientific Research

*THE product of scientific research is not alone the building of industry. It is not alone the eradication of disease nor the multiplication of harvests. It is not alone the extension of opportunity and adventure.*

*It is a certainty that research into the fundamental laws of nature contributes to the moral and spiritual life of mankind. Here lie the unfolding of beauty, the ever-widening of the boundaries of knowledge. Here is the "inculcation of veracity of thought" in a world sodden with intellectual dishonesty. Here is the lifting of men's minds beyond the depressing incidents of the day. Here is the confirmation of a Supreme Guidance in the universe far above man himself.*

*Our civilization is much like a garden. It is to be appraised by its blooms. We must fertilize its soil with liberty. We must be diligent in cultivation. We must be constant in expansion of its frontiers. We must guard it against destructive forces. Then will we produce more and more of those blossoms, the fragrance of whose lives stimulates increased endeavors, gives widening opportunity to youth and courage for the future* (Herbert Hoover).

## What is Cotton?

Cotton is the overcoat of a seed that is planted and grown in the Southern states to keep the producer broke and the buyer crazy. The fiber varies in color and weight and the man who can guess the nearest the length of a fiber is called a cotton man by the public, a fool by the farmer, and a poor business man by his creditors.

The price of cotton is fixed in New York and goes up when you have sold and down when you have bought. A buyer working for a group of mills was sent to New York to watch the cotton market and after a few days' deliberation wired his firm to this effect "Some think it will go up. Some think it will go down. I do, too. Whatever you do will be all wrong. Act at once."

Cotton is planted in the Spring, mortgaged in the Summer, and left in the field in Winter (Reprinted from the Boston News Bureau).

## Nominations for Officers

THE NOMINATING Committee to select nominees for Society officers met in Philadelphia on March 1. The personnel of this group was listed in the March BULLETIN. In accordance with the provisions of the By-laws of the Society, the following nominations are announced.

*For President:*

W. M. Barr, Chief Chemical and Metallurgical Engineer, Union Pacific Railroad Co., Omaha, Nebr.

*For Vice-President:*

H. J. Ball, Professor of Textile Engineering, Lowell Textile Institute, Lowell, Mass.

*For Members of Executive Committee:*

C. H. Fellows, Head, Chemical Division, Research Dept., The Detroit Edison Co., Detroit, Mich.

R. C. Griffin, Treasurer, Arthur D. Little, Inc., Cambridge, Mass.

P. D. Merica, Vice-President and Director, The International Nickel Co., Inc., New York, N. Y.

Jerome Strauss, Vice-President, Vanadium Corporation of America, New York, N. Y.

Stanton Walker, Director of Engineering, National Sand and Gravel Assn., Washington, D. C.

Each of the above nominees has indicated in writing his acceptance of his nomination. The By-laws provide that "further nominations, signed by at least 25 members, may be submitted to the Secretary-Treasurer in writing by May 25, and a nomination so made, if accepted by the member nominated, shall be placed on the official ballot" which "shall be issued to the members between May 25 and June 1."

## War Department Expands Contacts

FOR A NUMBER of years the Ordnance Department of the U. S. Army and other Army Divisions have participated in various phases of committee work through such men as Col. G. F. Jenks, Office of Chief of Ordnance; H. H. Lester, Senior Physicist, Watertown Arsenal; E. L. Wood, Plant Metallurgist, Springfield Armory; W. R. Koch, Materiel Division, Air Corps; and John Burlin Johnson, Chief, Material Section, Materiel Div., Air Corps, Wright Field, and others.

Recently the Army has indicated a keen interest in the work of several committees on which it was not represented, particularly in the field of non-ferrous metals and that of textiles. Accordingly Capt. L. S. Fletcher, Ordnance Dept., U. S. Army, Officer in Charge of Research Lab., Frankford Arsenal, Philadelphia, has been appointed as representative on the following committees: B-2 on Non-Ferrous Metals and Alloys, B-3 on Corrosion of Non-Ferrous Metals and Alloys, B-5 on Copper and Copper Alloys, Cast and Wrought, and B-6 on Die-Cast Metals and Alloys. The Quartermaster Corps of the U. S. Army will be represented on Committee D-13 on Textile Materials by Major L. R. Wolfe, office of the Quartermaster General, Standardization Branch, Washington, D. C.

Through its representatives the Ordnance Department has already aided actively in advancing certain phases of the Society's work, particularly in the field of copper and copper alloys, cast and wrought, as indicated in the March ASTM BULLETIN.

In the Government's industrial preparedness program cognizance has been taken of the importance of satisfactory standard specifications and test methods, and the Army's closer contacts with the various Society's committees are related to this work.

## Papers on Textiles and Petroleum at Scientific Congress

ANNOUNCEMENT WAS made in the March BULLETIN, of the Eighth American Scientific Congress, Washington, D. C., May 10 to 18, in connection with the advancement of scientific achievement and to celebrate the fiftieth anniversary of the founding of the Pan American Union. A statement from Dr. L. J. Briggs, Director, National Bureau of Standards, who is Chairman of Section VI on Physical and Chemical Sciences was published.

In connection with this program two active members of the Society, W. D. Appel, Chief, Textile Section, National Bureau of Standards, and Past-President T. G. Delbridge, Manager, Research and Development Dept., Atlantic Refining Co., have been invited to prepare contributions. Doctor Appel will cover the subject of testing and specifications for textiles while Doctor Delbridge's contribution will deal with petroleum products and lubricants.

## Die-Casting Committee Plans to Finance Corrosion Program

IN CONNECTION with its plans for continuing and expanding exposure and corrosion tests of certain die-casting metals and alloys, Committee B-6 on Die-Cast Metals and Alloys is faced with the problem of financing certain phases of the work including construction of exposure racks and handling charges, and a special committee will be appointed to handle the matter. The committee estimates that $2000 will be required to take care of the expenses. The B-6 subcommittee in charge plans to contact a number of organizations for support, including those concerned with consuming, as well as producing these materials.

Through its various researches involving exposure and corrosion tests and also other investigations, Committee B-6 has developed a great deal of valuable information and data for different kinds of die-casting alloys. Many of these data have been used as the basis for standard specifications. These specifications have been of great service in connection with both the consuming and producing angles of die casting.

The committee has endeavored to keep its work in line with rapidly moving trends in the industry and it is in this connection that the corrosion test program is being augmented by tests to be made on seven new types of alloys. The committee's first corrosion test program was started in 1929 and completed in 1939 as planned, after ten years. The data from these tests will be published with suitable comments on the part of the committee.

The new tests planned will cover a number of new alloys, some of which have superseded certain of the compositions used in the original tests. Because the new exposure racks will be used for different types of die-casting metals and alloys, the committee felt it in order to solicit support of various interests.

Facsimile of
Membership Certificate

American Society for Testing Materials

Incorporated 1902

This is to Certify that

John Richard Doe

on February 16th, 1938 was

Elected a Member of the

American Society for Testing Materials

a Corporation formed for the Promotion of Knowledge of the Materials of Engineering and the Standardization of Specifications and the Methods of Testing

Witness our hand and seal at Philadelphia, this day of 19

Secretary President

## Reduction in Cost of Membership Certificates

WHILE THE usual charge for a Certificate of Membership is $2.50, it has been decided that for the remainder of the year a reduction will be made in the price of the certificate and copies will be furnished at $1.50 each.

There will be no change in the quality or style of the certificate. The original engraving was prepared by a company doing the highest type of this work. A very heavy grade of parchment paper is used and the member's name, date of membership, and classification of his membership is carefully engrossed. The dimensions of the certificate are 22 by 17 in. and each is personally signed by the President of the Society and the Secretary-Treasurer, after which the official Society seal is affixed.

The Executive Committee believes that many members would wish to order a certificate if their attention was called to its availability and at a nominal cost. With this in mind a reduction of the price was decided upon.

---

**American Society for Testing Materials**
**260 S. Broad St.**
**Philadelphia, Pa.**

**Gentlemen:**

**I wish to obtain a Certificate of Membership. The exact name to be engrossed is as follows:**

.....

.....

**(signed)**.....

.....

**Date**..... .....

---

In ordering a copy either using the accompanying return coupon or by letter, members should specify exactly how they wish their names to appear. The Society's records, of course, furnish the information on the date of election and the classification of membership. In the case of company memberships be sure especially to indicate the spelling of the word "company" and the use of ampersands and the like.

## "The Good Old Days"???

Before shedding a tear for "the good old days" when retailing was known as storekeeping and personnel training programs included lessons on how to wield a broom, take a glance at a copy of the rules for employees of the original store of Carson, Pirie & Scott Co., Chicago, 80 years ago, uncovered recently:

STORE RULES

Store must be opened from 6 a.m. to 9 p.m. the year around.

Store must be swept; counters, base shelves, and showcases dusted; lamps trimmed, filled, and chimneys cleaned; pens made; doors and windows opened; a pail of water, also a bucket of coal brought in before breakfast (if there is time to do so), and attend to customers who call.

Stores must not be opened on the Sabbath unless necessary, and then for only a few minutes.

The employee who is in the habit of smoking Spanish cigars, being shaved at the barber's, going to dances and other places of amusement, will surely give his employer reason to be suspicious of his integrity and honesty.

Each employee must pay not less than $5.00 a year to the church and must attend Sunday School regularly.

Men employees are given one evening a week for courting and two if they go to prayer meeting.

After 14 hours of work in the store, the leisure hours should be spent mostly in reading.

Rochester Commerce,
Via *The Rochester Engineer*

## *Calendar of Society Meetings*

*(Arranged in Chronological Order)*

American Foundrymen's Association—Forty-fourth Annual Convention and Exhibition, May 6–10, Palmer House, Chicago, Ill.

American Institute of Chemical Engineers—Thirty-second Semi-Annual Meeting, May 13–15, Statler Hotel, Buffalo, N.Y.

Society of Automotive Engineers—Summer Meeting, June 9–14, The Greenbrier, White Sulphur Springs, W. Va.

American Society of Mechanical Engineers—Semi-Annual Meeting, June 17–21, Milwaukee, Wis.

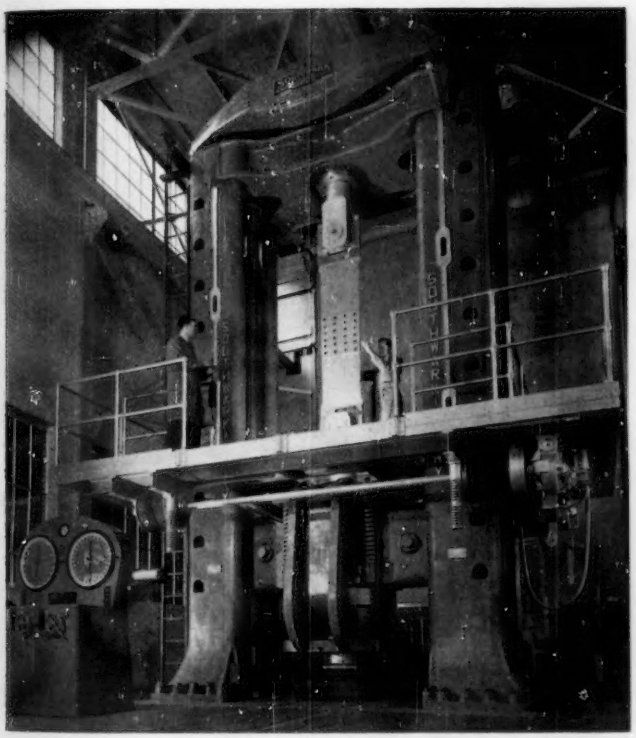
American Association for the Advancement of Science—Summer Meeting, June 17–22, Seattle, Washington.

**American Society for Testing Materials**—Forty-third Annual Meeting, June 24–28, Atlantic City, N. J.

American Institute of Electrical Engineers—Summer Convention, June 24–28, Swampscott, Mass.

Society for the Promotion of Engineering Education—Annual Meeting, June 25–28, University of California, Berkeley, Calif.

American Chemical Society—September 9–13, Detroit, Mich.



This new testing machine, built by Baldwin-Southwark and recently installed at the New Kensington plant of the Aluminum Company of America, is capable of exerting a force of 3,000,000 lb. in compression and 1,000,000 lb. in tension. It can exert these forces at speeds up to 36 in. per min. The machine, weighing 1500 tons, can also be operated as an extrusion, forging, or forming press. It is 40 ft. 4 in. high, of which 25 ft. are above the floor line and the rest below. For testing large structural specimens, a pump delivering 18 gal. of oil per min. is driven by a 20-hp. motor. A 300-hp. motor delivering 270 gal. per min. is used for high-speed testing. In both instances, oil is delivered at a pressure of 1800 lb. per sq. in. The machine, called the Templin machine, after R. L. Templin, chief engineer of tests, Aluminum Co., was demonstrated at an open-house on March 2.

## Catalogs and Literature Received

American Instrument Co., 8010–8020 Georgia Ave., Silver Spring, Md. Bulletin 2075 entitled "Aminco Lo Lag Electric Heaters and Controls." This 24-page publication describes Aminco heaters including the flexible type immersion heaters, screw-in (pipe-fitting) immersion heaters, convection type room heaters, oven heaters, and also covers thermoregulators, thermostats, relays and related equipment. Includes discussion on selection of heaters and controls, with tables of useful information, conversion tables, etc.

"Abridged Spectrophotometers," 14-page Bulletin No. 2080, covers theoretical considerations of this subject, describes operation of the neutral wedge photometer, with bibliography and other information.

Krebs Electric & Manufacturing Co., Inc., 237–239 Lafayette St., New York, N. Y. A four-page folder describing the constant temperature water bath for use with capillary viscometers, modified Ostwald viscometers, and the general purpose constant temperature water bath.

The Refinery Supply Co., 621 E. Fourth St., Tulsa, Okla. Three folders describing the Ac-Me specific gravity gas balance, the dew point tester for gases under pressure, and the Ac-Me recording gravitometer.

Colloid Equipment Co., Inc., 50 Church St., New York, N. Y. Descriptions of Delmhorst Moisture Detectors, their use in the ceramic industry, wood industry, etc.

Baldwin-Southwark Corp., Philadelphia, Pa. Bulletin 153, entitled "Strain Gages and Extensometers." This 16-page, profusely illustrated publication covers in detail a number of instruments including the de Forest scratch recording strain gage (with discussion of its applications and numerous illustrations of recordings); also describes the various types of this gage—straight target and motor-driven. Other extensometers include the H. F. Moore and Tripolitis, the averaging type dial extensometer, Huggenberger tensometer, bonded metalectric strain gages, etc.

Bulletin 154, entitled "Carpenter Torsion Impact Testing Machine," 7 pages, is a technical treatise on the use of the Carpenter Machine for testing brittle materials. Presents characteristic test results of three steels with an interpretation of the test.

Bulletin 155, "SR-r Bonded Metalectric Strain Gage," 8 pages, describes this strain gage and its use. Covers the use of the instrument for fatigue measurements and for dynamic and semi-dynamic strain measurements.

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## NEW MEMBERS TO APRIL 23, 1940

The following 30 members were elected from March 18 to April 23, 1940, making the total membership 4276:

### *Company Members* (11)

ALLEN MANUFACTURING CO., C. S. Gates, Factory Manager, P. O. Drawer 570, Hartford, Conn.

BALDWIN RUBBER CO., E. J. Kvet, Chief Chemist, Pontiac, Mich.

MADIGAN-HYLAND, R. V. Hyland, Co-Partner, 28-04 Forty-first Ave., Long Island City, N. Y.

MANHATTAN SOAP CO., INC., Israel Katz, Vice-President and General Manager, Bristol, Pa.

MONSANTO CHEMICAL CO., PLASTICS DIVISION, H. K. Nason, Assistant Director of Research, Springfield, Mass.

NEWARK TESTING LABORATORIES, L. D. Long, 80 Lafayette St., Newark, N. J.

QUIGLEY CO., INC., R. J. Demaison, Technical Adviser, 56 W. Forty-fifth St., New York, N. Y.

RAIL JOINT CO., INC., THE, E. A. Condit, Vice-President, 50 Church St., New York, N. Y.

*SHELL DEVELOPMENT CO., F. D. Tuemmler, Head, Analytical Dept., Fifty-third and Horton Sts., Emeryville, Calif.

STROMBERG-CARLSON TELEPHONE MANUFACTURING CO., F. C. Young, Chief Engineer, 100 Carlson Road, Rochester, N. Y.

THOMASTON COTTON MILLS, A. M. Moseley, Assistant Superintendent, Thomaston, Ga.

* See article on Sustaining Members, p. 39.

### *Individual and Other Members* (19)

ARNOLD, H. C., Chemist, Federal Enameling and Stamping Co., Pittsburgh, Pa. For mail: 76 Standish Boulevard, Mt. Lebanon, Pittsburgh, Pa.

ATKINSON, F. C., Chief Chemist, Frederick C. Atkinson, Inc., 213 E. South St., Indianapolis, Ind.

BRADLEY, D. T., Chief Engineer, Harris Products Co., 5408 Commonwealth Ave., Detroit, Mich.

COHOES, CITY OF, Hugh McKee, City Engineer, City Hall, Cohoes, N. Y.

DELMONTE, JOHN, Assistant Chief Engineer of Research and Development, Chicago Flexible Shaft Co., Chicago, Ill. For mail: 214 Vine Ave., Park Ridge, Ill.

HERON, S. D., Engineer, Ethyl Gasoline Corp., 723 E. Milwaukee Ave., Detroit, Mich.

HOUGHTON, DOROTHY, Instructor in Chemistry, Teachers College, Columbia University, 525 W. 120th St., New York, N. Y.

LYNCHBURG, CITY OF, R. F. Wagner, Director of Public Works, City Hall, Lynchburg, Va.

MOODY, W. A., Chemist, Seneca Petroleum Co., Chicago, Ill. For mail: 5541 Everett Ave., Chicago, Ill.

MURDOCK, W. F., General Manager, Metallic Products Division, The Eagle-Picher Lead Co., 435 Reading Road, Cincinnati, Ohio.

NEW MEXICO STATE HIGHWAY DEPT., B. G. Dwyre, State Highway Engineer, Santa Fe, N. Mex.

NORMAN, DANIEL, Spectroscopist, New England Spectrochemical Laboratories, 636 Beacon St., Boston, Mass.

OAKLAND, CITY OF, ENGINEERING LABORATORY, STREET DEPT., S. M. Hands, Testing Engineer, 501 Fifth Ave., Oakland, Calif.

REDDICK, J. D., Chief Draftsman, Electric Wheel Co., Quincy, Ill.

SAN FRANCISCO PUBLIC LIBRARY, Robert Rea, City Librarian, Civic Center, San Francisco, Calif.

TURNBULL, J. MACN., Assistant Engineer, In Charge of Testing and Research Dept., Hume Pipe Co. (Australia), Ltd., Melbourne, C. 1, Australia. For mail: 2 Howitt St., Glen Iris, S. E. 6, Melbourne, Australia.

ULRICH, C. E., Vice-President—Manager, The Flexcell Co., 919 N. Michigan Ave., Chicago, Ill.

WALKER, H. O., Chief Engineer, Hammond Iron Works, Warren, Pa.

WATKINS, S. P., Manager, Sales Development, Rustless Iron and Steel Corp., 3400 E. Chase St., Baltimore, Md.

## PERSONALS

* * * News items concerning the activities of our members will be welcomed for inclusion in this column.

ALEXANDER FOSTER, JR., Vice-President, The Warner Co., Philadelphia, Pa., was elected vice-president of the Pennsylvania Sand & Gravel Producers' Assn. at their annual meeting held in Harrisburg.

R. W. BAKER, formerly Sales Metallurgical Engineer, Republic Steel Corp., Cleveland, Ohio, is now Assistant to the President, The Flood Co., Cleveland.

C. E. SWARTZ, Metallurgist, Cleveland Graphite Bronze Co., Cleveland, Ohio, was made treasurer of the Cleveland Chapter, American Society for Metals.

F. M. ROBBINS, President, Ross-Meehan Foundries, Chattanooga, Tenn., and retiring president, Steel Founders Society of America, was awarded the Frederick A. Lorenz Memorial Medal for 1940 for "outstanding contribution to the welfare of the industry" during his term of office. Presentation was made at the annual meeting of the society in Chicago in February.

RAY MCBRIAN, Chemist, Burnham Shops, Denver & Rio Grande Western Railroad Co., Denver, Colo., has been made chairman of the newly organized A.S.M. Chapter in Colorado, known as the Rocky Mountain Group.

J. J. CROWE, Air Reduction Sales Co., New York, N. Y., has been appointed Assistant to the Vice-President and Operating Manager. Mr. Crowe will direct the activities of the apparatus research and development department and will coordinate these activities with similar activities for the Wilson Welder & Metals Co., Inc., a subsidiary of the Air Reduction Sales Co.

At the recent meeting of the American Concrete Institute, a number of A.S.T.M. members were honored in addition to the nominees for officers as listed in the January BULLETIN, who included Messrs. R. B. YOUNG, R. E. DAVIS, R. W. CRUM, and F. E. SCHMITT. STANTON WALKER, Director of Engineering, National Sand and Gravel Assn., Washington, D. C., was appointed to the Board of Direction to fill a vacancy. H. J. GILKEY, Head, Department of Theoretical and Applied Mechanics, Iowa State College, joint author with S. J. Chamberlin and R. W. Beal, was awarded the A.C.I. Wason Medal for the most meritorious paper in the A.C.I. *Proceedings*, Vol. 35 (1939), the paper being entitled "The Bond Between Concrete and Steel."

ISRAEL KATZ, formerly General Manager, J. Eavenson & Sons, Camden, N. J., is now Vice-President and General Manager, Manhattan Soap Co., Inc., Bristol, Pa.

J. O. BETTERTON, General Manager, Lead Refineries, American Smelting and Refining Co., Perth Amboy, N. J., has retired.

G. E. HOPKINS is now Technical Director, U. S. Asbestos Division, Raybestos-Manhattan, Inc., Manheim, Pa. He was Engineer, United Shoe Machinery Corp., Beverly, Mass.

R. L. HANKINSON, formerly Chief of Structural and Architectural Division, Bureau of Lighthouses, U. S. Department of Commerce, Washington, D. C., is now Commander, U. S. Coast Guard, Washington, D. C.

J. T. LITTLETON, who has been Chief of Physical Laboratory, Corning Glass Works, Corning, N. Y., has been promoted to the newly created position of Assistant Director of Research.

A. A. LEVISON, Blaw-Knox Co., Pittsburgh, Pa., has been elected a vice-chairman of the Manufacturers Division, National Sand and Gravel Assn.

F. L. LA QUE, who has been Assistant Director, Technical Service, Mill Products Development and Research Division, The International Nickel Co., Inc., is now Metallurgist, Development and Research Division.

R. E. COUGHLAN, formerly Supervisor of Water Supply, Chicago & Northwestern Railway, Chicago, Ill., has become Engineer of Tests. H. D. Browne, whom Mr. Coughlan succeeds, has retired from active duty.

# *Provisional Program*

## FORTY-THIRD ANNUAL MEETING

of the

## AMERICAN SOCIETY FOR TESTING MATERIALS

**ATLANTIC CITY, N. J.** **CHALFONTE-HADDON HALL** **JUNE 24 to 28, 1940**

*Summary*

| | Morning | Afternoon | Evening |
|---|---|---|---|
| *Monday,* June 24 | Registration<br>Committee Meetings | Committee Meetings | Committee Meetings |
| *Tuesday,* June 25 | 1. 10.30 a.m. Formal Opening Session | 2. Radiography<br>3. Symposium on Tools of Analytical Chemistry | 4. Water<br>5. Methods of Testing |
| *Wednesday,* June 26 | 6. Symposium on Tools of Analytical Chemistry (continued)<br>7. Symposium on Significance of the Tension Test in Relation to Design | Spectrochemical and Microanalytical Procedures (Motion Pictures)<br>8. Ceramic and Masonry Materials, Glass<br>9. Steel, Ferro-Alloys, Metallography<br>10. 4 p.m. Marburg Lecture—Dudley Medal Award | 11. Corrosion, Iron<br>12. Cement, Lime, Gypsum, Concrete |
| *Thursday,* June 27 | 13. Fatigue, Corrosion-Fatigue<br>14. Symposium on Spectrographic Analysis | 15. Symposium on Spectrographic Analysis (continued)<br>16. Effect of Temperature, Creep | 17. Petroleum Products, Bituminous Materials, Road Materials, Soils<br>18. Concrete (continued) |
| *Friday,* June 28 | 19. Textiles, Soaps, Paint, Timber, Paper, Fuels<br>20. Non-Ferrous Metals | 21. Non-Ferrous Metals (continued)<br>22. Plastics, Electrical Insulating Materials, Rubber | |

### Tuesday, June 25 10.30 a.m. First Session

### Formal Opening Session

### President's Address

**Formal Opening of the Forty-third Annual Meeting.**
President H. H. Morgan.

**Report of Committee E-9 on Research.** T. S. Fuller, Chairman.

Contains a brief discussion on the new research activities being undertaken or sponsored by Society committees, and references to the work of the several research committees.

**Report of Committee E-10 on Standards.** R. P. Anderson, Chairman.

Reports on specifications and methods of test submitted under the procedure for acceptance and publication of new and revised tentative standards and tentative revisions of existing standards in the interim between annual meetings of the Society.

**Annual Report of the Executive Committee.** C. L. Warwick, Secretary-Treasurer.

A general report of Society activities with particular reference to membership, publications, finances, and administrative matters relating to committee activities and inter-society relations.

**Address—"Materials Standards in Industrial Preparedness."** Lieut.-Col. William C. Young, Planning Branch, Office of the Assistant Secretary of War.

A discussion of industrial preparedness, and the relationship thereto of standards for materials and the work of the American Society for Testing Materials.

**Annual Address by the President,** H. H. Morgan.

**Recognition of Forty-year Members.**

**Award of Honorary Memberships.**

**Introduction of Newly Elected Officers.**

The terms of the new officers, under the provisions of the By-laws, begin at the close of the annual meeting.

**Miscellaneous Business.**

### Tuesday, June 25 2 p.m. Second Session

Held Simultaneously with Third Session

### Radiography

**Report of Committee E-7 on Radiographic Testing.** H. H. Lester, Chairman.

This progress report describes briefly the considerations being given by the committee to the preparation of recommendations on radiography of cast metal and the radiographic examination of welds and weldments.

**The Technique of Inspecting Wood Poles by X-ray.** Myron Zucker, The Detroit Edison Co.

Fluoroscopic, radiographic, and photo-fluoroscopic methods have been investigated to detect rot in standing poles. With the proper technique, various stages and degrees of rot may be discerned under the wide variety of conditions met by electric utilities. Mechanical

aids were designed for taking radiographs and measuring the strength of good wood in each pole. Laboratory work was supplemented by field tests which indicated that accuracy was satisfactory and costs were reasonable. It is indicated that pole life may be increased both through scientific inspection and through study of the progress of rot. The technique may also be useful in related fields.

**The Reduction of Secondary Radiation and of Excessive Radiographic Contrast by Filtration.** Herman E. Seemann, Eastman Kodak Co.

In many cases, the filter technique is a satisfactory substitute for multiple exposures or elaborate masking in the radiography of irregular objects. This paper shows that considerable reduction of secondary radiation from the filter may be effected by placing it as near the X-ray tube as possible instead of on the cassette. The use of a filter also reduces subject contrast so that more of the radiograph has diagnostic value. Representative exposure data are given.

**Observations on Radiography at One Million Volts.** Carlton G. Lutts, U. S. Navy Yard, J. T. Norton, and J. G. Trump, Massachusetts Institute of Technology.

Shows that results obtained with high-voltage X-rays and with gamma rays are comparable in quality. In both cases the whole range of thicknesses of a special test block, varying in thickness from 1 to 4 in. and containing artificial defects, could be recorded in a single exposure, and the sensitivity as shown by the artificial defects was the same in both cases. The exposure times, however, were widely different.

The results emphasize the fact that the enormous saving in time when using the high voltage unit is combined with the wide latitude of the gamma-ray method. The low voltage X-ray method provides some improvement in ability to detect small defects but at the expense of the wide latitude.

## Tuesday, June 25 2 p.m. Third Session

Held Simultaneously with Second Session

## Symposium on Tools of Analytical Chemistry

In this symposium, the Society will act as host to the analytic members of the Physical and Inorganic Chemistry Division of the American Chemical Society, for the purpose of presenting recent developments in chemical analysis and of providing an opportunity to discuss common problems. The program will cover newer trends in analytical chemistry such as microanalysis, polarography, chromatography, internal electrolysis, and radioactive indicators, electronic circuits applied to analytical chemical procedures, the theory and practice of pH determinations and control using the glass electrode, micro-gas analysis methods and their application to research, new and forgotten aspects of organic compounds in inorganic analysis, and recent developments in cerate oxidimetry. Developments in spectrochemical analysis will be covered in the Symposium on Spectrographic Analysis, which will tie in closely with the Analytical Symposium.

**Some Newer Trends in Analytical Chemistry.** Beverly L. Clarke, Bell Telephone Laboratories, Inc.

**Electronic Instruments in Analysis, Testing and Control.** Ralph H. Müller, Washington Square College, New York University.

**Theory and Practice of pH Determinations and Control Using the Glass Electrode.** Malcolm Dole, Northwestern University.

(Symposium continued in Sixth Session)

## Tuesday, June 25 8 p.m. Fourth Session

Held Simultaneously with Fifth Session

## Water

**Report of Committee D-19 on Water for Industrial Uses.** Max Hecht, Chairman.

A new method for reporting the analysis of water intended for industrial use is submitted. Revisions are presented in five of the present tentative standards which cover methods of sampling, procedures for determining calcium ion and magnesium ion, chloride ion, total orthophosphate and orthophosphate ion, and sulfate ion in industrial waters.

### *Symposium on Problems in the Classification of Natural Water Intended for Industrial Use*

The purpose of this symposium is to develop uniformity in reporting water analysis and to secure data from which specifications may be developed, these data permitting the expression of corrosivity and deposit-protection characteristics. The data may be secured by utilizing testing procedures and formulas that have been found to give reasonable approximation of rates of corrosion and of deposit formation.

The classification of the corrosivity and the deposit-forming characteristics of natural water, intended for industrial use, in service conduits and containers, is desirable for critically examining, testing procedures, existing formulas, and their future developments.

**Introduction.** F. N. Speller, Consulting Metallurgical Engineer.

**Reporting the Results of Water Analysis.** Robert C. Adams, U. S. Naval Engineering Experiment Station.

Describes the present confusion resulting from the numerous units and groups of units used in reports of water analysis and points out the desirability of a uniform system. Outlines the method proposed by Committee D-19 on Water for Industrial Uses and submits a specimen report in the proposed system converted from a report in another system taken from a published paper. Demonstrates by examples the ease of calculations based upon the proposed system.

**A Review of Data on the Relationship of Corrosivity of Water to Its Chemical Analysis.** V. V. Kendall, National Tube Co.

Previous efforts to correlate corrosivity of water and composition are reviewed. Correlation with present methods is satisfactory within certain ranges. More fundamental data are required before these ranges can be narrowed.

**Measuring the Scale-Forming and Corrosive Tendencies of Water by Short-Time Tests.** Everett P. Partridge and G. B. Hatch, Hall Laboratories, Inc.

Measurement of the scale-forming and corrosive properties of water by direct test is recommended in place of or as a supplement to estimation of its behavior by chemical analysis alone. Methods of testing requiring from a few hours to a few days are described. Particular attention is directed to continuous-flow methods and to the great effect which some substances, even when present only to the extent of a few parts per million, may exert upon both scale deposition and corrosion.

**A Method of Measuring Corrosiveness.** J. H. Walker, The Detroit Edison Co.

Describes a corrosion tester developed by the Corrosion Committee of the National District Heating Assn. and extensively used by member companies of that organization. The device is intended to measure the corrosiveness of the condensate in steam-heating systems. Particular reference is made to its use in some work by The Detroit Edison Co., in which the corrosiveness of the condensate from steam from four district heating plants having different methods of feedwater treatment was measured in a standard test apparatus embodying the N.D.H.A. corrosion tester.

## Tuesday, June 25 8 p.m. Fifth Session

Held Simultaneously with Fourth Session

# Methods of Testing

**Report of Committee E-1 on Methods of Testing.** W. H. Fulweiler, Chairman.

This report submits for publication as tentative revised methods of tension testing for metallic materials; also recommended practices for designation of numerical requirements in standards. New tentative specifications are also included for an A.S.T.M. turpentine thermometer and proposed requirements for three aniline point thermometers are submitted as information. Revised definitions of terms relating to rheological properties of matter are appended.

The report also contains a brief summary of the activities of the technical committees on mechanical testing, consistency and plasticity, particle size and shape, density, chemical composition, thickness measurement, interpretation and presentation of data, designation and interpretation of numerical requirements, conditioning, and laboratory apparatus.

**Paper Appended:**

Methods of Testing Volumetric Glassware. J. J. Moran, Kimble Glass Co.

Covers referee methods of testing volumetric glassware which can be used to check the accuracy of graduated ware supplied under A.S.T.M. specifications. Proper methods of reading the meniscus are discussed as well as the cleanliness required of an apparatus before it can be recalibrated. The proper method of setting the liquid on the calibration mark preparatory to reading as well as some comment on the liquid to be employed in testing is also given.

**An Investigation of the Effect of Rate of Strain on the Results of Tension Tests of Metals.** Paul G. Jones and H. F. Moore, University of Illinois.

Results of tension tests on 14 metals are reported using different speeds of testing. The apparatus used was autographic and employed a duplicate apparatus for weighing load—a compression block with carbon-pile compressometer and, in series with it, a steel tension weighbar with an electric resistance extensometer. Stretch of specimen was measured by means of an electric resistance extensometer. Time records were made photographically on an oscillograph film by contacts fitted to an electric clock.

Proposed methods for determining rates of strain in tension tests using a type of testing machine in common use, not equipped with any special control apparatus, are also presented.

**Speed in Tension Testing and Its Effect on Yield Point Values.** Lawford H. Fry, Edgewater Steel Co.

The yield point value varies with the speed at which the test is pulled. This variation is directly related to the rate at which the specimen is loaded and only indirectly to the crosshead speed. The rate at which load is applied in a given machine varies with the load. Therefore, the rate of loading at the yield point cannot be determined by a single measurement over a range of loads below the yield point. The relation between rate of loading and load is different for different machines and in a given machine is dependent on the type of test specimen. For a given machine and a given type of specimen, a loading modulus is found which expresses the pounds of load added per inch of travel of the crosshead. This varies with the load, but is generally independent of the speed of the machine.

**Report of Committee E-3 on Chemical Analysis of Metals.** G. E. F. Lundell, Chairman.

A progress report reviewing briefly the work under way on analytical procedures and sampling methods for non-ferrous metals and alloys.

**Report of Committee E-2 on Spectrographic Analysis.** H. V. Churchill, Chairman.

This progress report discusses briefly the considerations being given by the committee to fundamental methods and technique; also quantitative methods and their application, and accessory uses of the spectrograph.

**Quantitative Spectrographic Analysis of Steels.** S. Vigo, Watertown Arsenal.

Analysis with a 3-meter grating spectrograph and microphotometer is described. Spectrographic determinations of molybdenum, vanadium, chromium, silicon, manganese, copper, aluminum, and titanium are routine practice. Analysis, restricted to alloy contents of less than 1.5 per cent, is based on spark spectra of standard steels. Average relative error is less than 5 per cent in routine analysis, except for silicon, in which the error is about 8 per cent. Data on reproducibility are included.

**Report of Committee E-8 on Nomenclature and Definitions.** Cloyd M. Chapman, Chairman.

Reports the actions taken by the committee on a number of recommendations on definitions submitted to it by the individual standing committees.

## Wednesday, June 26 9.30 a.m. Sixth Session

Held Simultaneously with Seventh Session

# Symposium on Tools of Analytical Chemistry *(Continued from Third Session)*

**Some New and Forgotten Aspects of Organic Compounds in Inorganic Analysis.** Harvey Diehl, Iowa State College.

**Cerate Oxidimetry.** G. Frederick Smith, University of Illinois, and H. H. Willard, University of Michigan.

**Micro-Gas Analysis Methods and Their Application to Research** L. A. Wooten, Bell Telephone Laboratories, Inc.

## Wednesday, June 26 9.30 a.m. Seventh Session

Held Simultaneously with Sixth Session

# Symposium on Significance of the Tension Test in Relation to Design

The tension test is one of the most important of the mechanical tests of metals. In spite of its universal use there are still certain differences of opinion regarding the significance of the results obtained. In view of the increased activity in developing codes for working stresses on the part of designing engineers, in which tension test results play an important part, it seems fitting to attempt to coordinate various viewpoints regarding strength and ductility.

With this objective in view the above symposium is presented which consists of three formal technical papers covering the general aspects of the tension test, the strength, and also the ductility features. It is hoped that all those who are interested in the physical significance of the qualities determined will participate in the discussion.

**Introduction.** John M. Lessells, Massachusetts Institute of Technology.

**The Tension Test.** C. W. MacGregor, Massachusetts Institute of Technology.

Following a summary of previous work relating to the general subject of the tension test, strain and reduction of area values are treated from a fundamental aspect. Newer concepts of strain and ductility values are discussed in the light of recent tests carried out at the Massachusetts Institute of Technology, and the relationships between the various strain definitions are described. True stress-strain curves for various materials are shown followed by several methods for their construction. The physical significance of these curves is discussed.

**The Strength Features of the Tension Test.** F. B. Seely, University of Illinois.

Discusses the influence on strength values obtained from the tension test of the haphazardly progressive slips in the grains of polycrystalline aggregates. Importance is placed on the conditions that change the mode of structural failure from general yielding (plastic deformation accompanied by strain hardening), associated with shearing stress, to failure by brittle fracture in which the cohesive strength of the material is exceeded, associated with tensile stress unaccompanied by plastic deformation and strain hardening. The relation of stress concentration to these two modes of failure is emphasized....The significance of yield strength, of upper and lower yield points, and of high yield-ratio steels is also discussed.

**The Limited Significance of the Ductility Features of the Tension Test.** H. W. Gillett, Battelle Memorial Institute.

Ability for plastic deformation is required in metal for fabrication by deep drawing, or the like, but ductility is no certain measure of this property. Ability to "give" enough to redistribute stress, as among the various members of a bridge, is required, but the degree of ductility needed for this purpose is very small. Toughness may be called for purely as an insurance policy, to provide that, in accidental failure, fracture occurs by yielding rather than by snapping off, but ductility is not a sufficient measure of this property.

Even where ductility is not needed for one of the three reasons cited above, high ductility is often demanded in the belief that it connotes quality.

## Wednesday, June 26 2 p.m.

Held Simultaneously with Eighth and Ninth Sessions

## Spectrochemical and Microanalytical Procedures

A short session, of interest in connection with both the Symposium on Tools of Analytical Chemistry (Third and Sixth Sessions) and the Symposium on Spectrographic Analysis (Fourteenth and Fifteenth Sessions), is planned at which there will be shown motion pictures dealing with spectrochemical and microanalytical installations in industry.

## Wednesday, June 26 2 p.m. Eighth Session

Held Simultaneously with Ninth Session

## Ceramic and Masonry Materials, Glass

**Report of Committee C-15 on Manufactured Masonry Units.** D. E. Parsons, Chairman.

This report recommends the adoption as standard of the tentative specifications for solid load-bearing concrete masonry units and presents a revision in the tentative specifications for building brick made from clay or shale. The report also summarizes the activities of the committee and the considerations being given to factors affecting the resistance of building brick to frost action and an investigation of paving brick to obtain data as a basis for revising the existing specifications, and to the preparation of specifications for smooth facing tile.

**Relation of Water Absorption and Strength of Brick to Abrasive Resistance.** J. W. McBurney, R. H. Brink, and A. R. Eberle, National Bureau of Standards.

The Kessler Portable Abrasion Tester was used to determine the comparative abrasive resistance of approximately 50 clay, shale, and fireclay bricks of known strength and absorption. These bricks were selected to represent the maximum range in properties commercially available. The results indicate that the abrasive resistance increases with increasing compressive strength and decreases with increasing absorption.

**Report of Committee C-5 on Fire Tests of Materials and Construction.** R. P. Miller, Chairman.

Presents new tentative methods applicable to door assemblies of various materials and of various types of construction for installation as wall-opening protectives to serve against the passage of fire, heat, or smoke. As the result of several years' experience with the tentative specifications for fire-retardant properties of wood for scaffolding and shoring, important revisions are recommended. A number of editorial changes and improvements in the standard specifications for fire tests of building construction and materials are submitted as tentative.

**Report of Committee C-8 on Refractories.** J. D. Sullivan, Chairman.

This report presents revised specifications for refractories for heavy duty and moderate duty for stationary boiler service; also for refractories for incinerator and for malleable iron furnaces. A new method of test for warpage of refractory brick and tile is submitted as tentative together with a classification of insulating refractories and new definitions of four terms used in the refractories industry. In addition, the committee is submitting tentative revisions in four standards and a number of editorial changes in the specifications and methods of test under its jurisdiction.

**Report of Committee C-4 on Clay Pipe.** Anson Marston, Chairman.

This committee is recommending the adoption as standard of the tentative revision published since 1938, providing for increased crushing strength requirements for clay sewer pipe 18 to 36 in. in internal diameter. The tentative definitions of terms relating to clay sewer pipe are recommended for withdrawal.

## Wednesday, June 26 2 p.m. Ninth Session

Held Simultaneously with Eighth Session

## Steel, Ferro-Alloys, Metallography

**Report of Committee A-1 on Steel.** N. L. Mochel, Chairman.

Included in the many recommendations of the Steel Committee are five proposed tentative specifications, one covering factory-made wrought carbon-steel and carbon-molybdenum welded fittings for pressure piping, four covering carbon-steel and alloy-steel forgings pertaining, respectively, to material for general industrial use and for railroads—locomotives, car construction, etc. When the latter are approved several existing and overlapping forging specifications will be withdrawn.

Numerous revisions in both standard and tentative specifications are included, most of those for standards being for immediate adoption. Many of the pipe and tubular specifications are involved, one important change covering procedures of hardness testing. In certain items new compositions are being added and the chemical requirements of existing grades are being changed. Hydrostatic test requirements are being modified and coordinated. A new grade of high-strength boiler rivet steel is recommended. Important changes are proposed in requirements for materials for high-temperature and high-pressure service. Other changes involve marking requirements in several pipe specifications.

**Coupon Tests of Structural Steels.** G. E. Troxell and H. E. Davis, University of California.

The results of tests of over 500 coupons taken from 80 large riveted joints of carbon, silicon, and nickel steels are reported. In addition to comparing the physical properties, including the modulus of elasticity of the steels, the variation in the coupon test results for each type of steel is shown. In comparing the results of commercial laboratory (rapid loading) tests and research laboratory (slow loading) tests it appears that the former give higher strengths and lower ductilities. The strengths of wide plates are shown to be somewhat lower than for coupons cut from them. Data on shear and tensile strengths of rivet stock, of both carbon and manganese steel, are included.

**Report of Committee A-6 on Magnetic Properties.** Thomas Spooner, Chairman.

Presents a revision of the tentative method of test for measuring interlamination resistance of steel. The report discusses the work being carried on by the committee on the study of direct current

test methods and on an investigation of methods of measuring core losses and a-c. permeability on small Epstein samples to determine the reproducibility of results.

**Report of Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel, and Related Alloys.** Jerome Strauss, Chairman.

A brief summary of committee activities is presented. The compilation of data on chemical analysis, mechanical properties, and heat treatment of the chromium and chromium-nickel alloys is expected to be completed during the year. Further considerations are being given to corrosion tests and to a survey of available information on boiling liquid test methods. The report discusses the interest of the committee in the welding of stainless steels and particularly in the formulation of a code for welded structures other than pressure vessels.

**Report of Sectional Committee B36 on Standardization of Dimensions and Materials of Wrought-Iron and Wrought-Steel Pipe and Tubing.** H. H. Morgan, Chairman.

The action of the committee in approving revisions in a number of standard specifications for pipe materials which are part of the American Standard B36.10-1939 is reported. The effort of the committee in furthering the acceptance of the American standard is briefly discussed.

**Report of Committee E-4 on Metallography.** L. L. Wyman, Chairman.

This progress report is devoted to a brief summary of the activities of the committee on photography, X-ray diffraction, dilatometric analysis, metallographic standards for grain size of ferrous and non-ferrous metals, and for nonmetallic inclusions in metals and alloys.

## Wednesday, June 26 4 p.m. Tenth Session

## Marburg Lecture—Dudley Medal Award

The purpose of the Edgar Marburg Lecture is to have described at the annual meetings of the Society, by leaders in their respective fields, outstanding developments in the promotion of knowledge of engineering materials. Established as a means of emphasizing the importance of promoting knowledge of materials, the Lecture honors and perpetuates the memory of Edgar Marburg, first secretary of the Society.

**Fifteenth Edgar Marburg Lecture:** "Portland Cement—Theories (Proved and Otherwise) and Specifications."

By P. H. Bates, Chief, Clay and Silicate Products Division, National Bureau of Standards.

The theme of the Marburg Lecture this year will be largely given over to portland cement specifications. While the basis and significance of a proposed tentative standard for five types of cement will occupy most of the time, there will be discussed briefly our knowledge of what this commodity is and to a lesser degree how it reacts in contact with water. Since at the present time much attention is paid to basic research, the effect of admixtures as aids in production and for durability, new not generally accepted test methods, heats of reaction with water, etc., these will be reviewed in some detail.

**Award of Charles B. Dudley Medal.**

To T. F. Willis and M. E. De Reus, Research Engineer, and Junior Engineer, respectively, Bureau of Materials, Missouri State Highway Dept.

The Fourteenth Award of the Charles B. Dudley Medal will be made to T. F. Willis and M. E. De Reus, Research Engineer, and Junior Engineer, respectively, Bureau of Materials, Missouri State Highway Dept., for their paper on "Thermal Volume Change and Elasticity of Aggregates and Their Effect on Concrete," presented before the Society at the 1939 Annual Meeting.

An annual award is made to the author or authors of a paper of outstanding merit constituting an original contribution on research in engineering materials. Established as a means of stimulating research in materials and of recognizing meritorious contributions, it commemorates the name of the first president of the Society.

## Wednesday, June 26 8 p.m. Eleventh Session

Held Simultaneously with Twelfth Session

## Corrosion, Iron

**Report of Committee A-5 on Corrosion of Iron and Steel.** W. H. Finkeldey, Chairman.

Presents final results of the total immersion tests on copper-bearing and non-copper-bearing sheets of Nos. 16 and 22 gage exposed at Key West, Fla., and Portsmouth, N. H. since 1927. Further failures in the atmospheric corrosion tests of sheets exposed at Annapolis, Md. have occurred. Results of latest inspections of the field exposure tests of zinc-coated corrugated sheets, at five test sites are included. The progress of the comprehensive test program being conducted at 11 test sites on specimens of farm-field fencing and fence wire is briefly discussed.

A consolidated method of test for uniformity of coating by the Preece test on zinc-coated iron or steel articles is presented for publication as tentative. Revisions are also included in the three specifications for electrodeposited coatings on steel and in the methods of test for local thickness of these coatings.

**Atmospheric Durability of Steels Containing Nickel and Copper.** N. B. Pilling and W. A. Wesley, The International Nickel Co., Inc.

Several series of atmospheric exposure tests have been made upon sheet specimens of low-alloy steels containing both nickel and copper, prepared from laboratory and larger melts. One series consists of large specimens simulating some of the conditions to which roofing sheets are exposed in practice. Rural, urban, industrial, and marine atmospheres were represented in the test sites. The beneficial effects of nickel upon the weathering characteristics of steel are shown to increase with increasing nickel content and are enhanced by the addition of optimum amounts of copper.

**Report of Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys.** T. S. Fuller, Chairman.

Considerations are being given by this committee to various types of corrosion test. These include the total immersion and alternate immersion tests, salt spray, atmospheric corrosion, and galvanic and electrolytic corrosion studies. Work recently undertaken on specifications has resulted in preparation of proposed specifications for nickel and chromium coatings on zinc and zinc alloys and on copper and copper alloys.

**Papers Appended:**

The Influence of Cathode Area and Circuit Resistance in Galvanic Corrosion. W. A. Wesley, The International Nickel Co., Inc.

Data are presented showing the effects of variation in cathode area and galvanic circuit resistance upon the current and the loss in weight of the anode in corrosion tests on iron coupled with copper in a neutral salt solution. Polarization curves for iron and copper were determined. The graphic method of estimating galvanic currents from such curves is discussed. This leads to derivation of a simple equation relating the current, the anode and cathode areas, and the resistance, which satisfactorily expresses the results of the corrosion experiments.

Some Observations of the Potentials of Metals and Alloys in Sea Water. F. L. LaQue and G. L. Cox, The International Nickel Co., Inc.

This paper comprises a review of the literature on the potentials of metals and alloys in sea water and similar chloride solutions, and a description of a particular method of determining potentials of a number of metals and alloys comprising the use of specimens in the form of pipe through which salt water is circulated during the test period of about six months. All of the data are used in setting up a galvanic series referring to sea water which has established the relative positions of about forty common metals and alloys.

**Informal Report of Joint Committee on Exposure Tests of Plating on the Non-Ferrous Metals.** William Blum, Chairman.

**The Adhesion of Nickel Deposits and a Study of the Ollard Adhesion Test Method.** E. J. Roehl, The International Nickel Co., Inc.

An experimental study of the Ollard adhesion test shows that suitable modification of the dimensions of test specimen and apparatus leads to a closer approach to a simple tensile stress at the interface between basis metal and the deposit. The adhesion test was used to evaluate methods of etching several steels and cast irons in preparation for nickel plating. The best of these methods result in adhesion greater than the strength of the deposit or base. Perfect adhesion of nickel on nickel is exemplified by continuation of the metallographic structure of the nickel base into the deposit itself.

**Report of Committee A-3 on Cast Iron.** W. H. Rother, Chairman.

This report recommends the adoption as standard of three tentative specifications covering automotive gray-iron castings, cast-iron pit-cast pipe for water and other liquids, and lightweight and thin-sectioned gray-iron castings. The pending tentative revision of the standard specifications for gray iron castings for valves, flanges, and pipe fittings, which provides for the inclusion of a high-test cast iron with a tensile strength of 41,000 psi. is recommended for adoption as standard. Reports that a draft of proposed revised specifications for pig iron has been completed.

**Report of Sectional Committee A21 on Specifications for Cast-Iron Pipe and Fittings.** T. H. Wiggin, Chairman.

**Mechanical Properties of Gray Cast Iron.** Jasper O. Draffin, W. L. Collins, and C. H. Casberg, University of Illinois.

Covers an extension of tests presented in a paper entitled "Effect of Size and Type of Specimen on the Torsional Properties of Cast Iron," published in the A.S.T.M. *Proceedings*, Vol. 38, Part II, p. 235.

The specimens are larger, 4 1/2 in. and 3 1/2 in. in outside diameter and with a range of wall thicknesses, than those tested previously and permit the use of smaller ratios of wall thickness to outside diameter than were used before. Discusses the relationship between the tensile strength and the modulus of rupture in torsion for all ratios of wall thickness to outside diameter.

**Report of Committee A-7 on Malleable Iron Castings.** E. K. Smith, Chairman.

A progress report on the activities of the committee in obtaining information and data respecting the physical properties of pearlitic malleable iron castings as a basis for revising the existing tentative specifications. It also discusses briefly the work under way in collecting information from all available sources concerning the welding of malleable iron.

**Properties of Commercial Pearlitic Malleable Irons.** C. H. Lorig, Battelle Memorial Institute.

This paper was prepared at the suggestion of Committee A-7 on Malleable Iron Castings. It presents the physical properties of each commercial pearlitic malleable iron and classifies it according to manufacture and heat treatment. Each producer of pearlitic malleable iron was asked to submit properties of his materials. The properties are listed in tables. The current literature is briefly reviewed and there is a general statement on heat treating procedures for producing pearlitic malleable iron.

**Stress-Strain Relations for Malleable Cast Iron in Tension with Special Attention to Yield Point Determination.** R. D. Landon, Southern Methodist University.

Lack of agreement between the behavior of certain test specimens and the present specifications for physical testing led to the investigation of the following properties of 141 specimens: modulus of elasticity, stress-strain relations for elongations in 2 in. from 0 to 0.05 in., and percentage elongation. Minimum, maximum, and average values are compared. Based on the results obtained, suggested changes both in specifications for testing and in testing procedure are made.

## Wednesday, June 26 8 p.m. Twelfth Session

Held Simultaneously with Eleventh Session

## Cement, Lime, Gypsum, Concrete

**Report of Committee C-11 on Gypsum.** L. S. Wells, Chairman.

Presents for immediate adoption revisions in five existing standard specifications for gypsum, providing for changes in the marking requirements for packaging of gypsum products so that they will be in accord with state regulations. A change in the scope of the standard specifications for gypsum lath is also presented since this standard covers both plain and perforated lath. Important changes are recommended in the standard specifications for Keene's cement and a new test for wood-fiber content in wood-fibered gypsum plaster is approved for adoption as standard.

**Report of Committee C-7 on Lime.** James R. Withrow, Chairman.

**Report of Committee C-12 on Mortars for Unit Masonry.** J. W. McBurney, Chairman.

This progress report discusses the activities of the committee and announces the organization of three new subcommittees on admixtures for mortar, on mortar for glass blocks, and on efflorescence. Reference is made to work under way on studies of the flow test for mortar and of a research program on shrinkage and expansion of mortar.

**Informal Report of Sectional Committee A42 on Specifications for Plastering.** W. R. McCornack, Chairman.

**Report of Committee C-1 on Cement.** P. H. Bates, Chairman.

The major accomplishment of the committee during the year is the development of new tentative specifications embracing five types of portland cement. A test for soundness of portland cement by means of the autoclave expansion test is also offered as tentative. The ammonium chloride methods for determining silicon dioxide, calcium oxide, and magnesium oxide are submitted as tentative to supplement the present analytical methods. A new staining test for masonry cement is presented for inclusion in the tentative specifications.

Appended is a report of the working committee on plastic mortar tests which contains results of an extensive series of tests on 2-in. cubes by seven laboratories on six cements and employing six mixes. The results of cooperative tests by 30 laboratories using 221 cements in studies of certain variations in types of test specimens and in methods of conducting the autoclave test are included in the report of the working committee on volume change and soundness.

**A Comparison of Mechanical and Optical Methods for Size Analysis of Cement.** P. S. Roller, U. S. Bureau of Mines, and P. V. Roundy, Jr., American Instrument Co.

Describes a mechanical method which involves the separation of a series of size fractions and the determination of the percentage of each from the weight of the fraction. The size or shape of the apparatus has no effect on the result within limit of error, and the percentages are dependent only on a prime variable, the velocity of the air. A comparison is made of mechanical results with those obtained with a Wagner turbidimeter.

**Some Properties of Mortar in Masonry.** F. O. Anderegg, Owens-Corning Fiberglas Corp.

The properties of masonry mortars should be determined only with specimens fabricated in contact with masonry units. The combination of compacting and suction produces definite effects, about which little has been known. The volume of mortar in masonry has only a small change when wetted or dried, and seems to be independent of the mix. The compressive strength of mortar cubes fabricated in metal molds does not correlate with the crushing strength of mortar taken from brick joints.

A method has been devised, aided by the application of a dye to indicate incomplete contact, for fabricating brick beams, which yields concordant flexural strengths.

**Tests of 110 Commercial Cements for Sulfate Resistance.** Dalton G. Miller and Philip W. Manson, University of Minnesota.

Results of observations of the sulfate resistance of 110 commercial cements are reported based on tests of six thousand 2 by 4-in. concrete cylinders, some of which were continuously immersed for 5 yr. in the laboratory in 1 per cent solutions of magnesium sulfate ($MgSO_4$), some in 1 per cent sodium sulfate ($Na_2SO_4$), and some in the water of Medicine Lake, South Dakota. This lake has averaged during the 5-yr. period, 12 per cent total salts, of which two-thirds are magnesium sulfate and one-fourth, sodium sulfate. All cylinders were made of aggregates, from a single source, with a maximum screen size of 3/8 in. and a fineness modulus of 4.67. The mix was 1:3 and the water-cement ratio 0.60 to 0.66. All cylinders exposed to the laboratory solutions were immersed in the solutions at 21 days following curing in the moist closet for 24 hr. and water for 20 days. The Medicine Lake cylinders were similarly cured plus 35 days in air.

**A Method of Measuring Thermal Diffusivity and Conductivity of Stone and Concrete.** W. T. Thomson, Kansas State College of Agriculture and Applied Mechanics.

In dealing with the transient flow of heat through a material, a term which is of particular importance is the thermal diffusivity. It expresses the rate of change of temperature throughout the body and is defined as the ratio of the thermal conductivity to the product of the density and specific heat. Due to the difficulty of determining the correct value of Biot's modulus which is an indication of the surface conditions, the diffusivity is generally determined indirectly in terms of the other two thermal constants. This paper presents a

simple method of determining the thermal diffusivity directly. Having obtained the diffusivity, the conductivity may indirectly be determined.

**The Theory of Concrete Creep.** William R. Lorman, Bureau of Reclamation, U. S. Department of the Interior.

The phenomenon of creep is defined and briefly described. The explanation of the manner in which creep and shrinkage occur is based on the gel theory. For constant sustained load the creep-time relation is expressed by a hyperbolic type of equation. The creep-time equations for variable sustained load are derived from the above basic creep law. Correlation of experimental creep data has made possible the establishment of the fundamental principles governing the values of the creep constants in the above equations.

**Autogenous Volume Changes of Concrete.** H. E. Davis, University of California.

Discusses autogenous volume changes in concrete, that is, the variations in volume due to other than external causes, such as: loads, moisture changes, and temperature changes. Results of observations extending over periods from 1 to 3 yr., on concrete specimens which have been stored in sealed containers, are reported. Tests include observations on concrete made with normal, low-heat and portland-pozzuolana cement. Data of this type are of interest in connection with strain measurements in mass-concerted structures.

(Concrete continued in Eighteenth Session)

## Thursday, June 27 9.30 a.m. Thirteenth Session

Held Simultaneously with Fourteenth Session

## Fatigue, Corrosion-Fatigue

**Informal Report of Research Committee on Fatigue of Metals.** H. F. Moore, Chairman.

**Fatigue of Porous Metals.** Claus G. Goetzel, American Electro Metal Corp., and Richard P. Seelig, Powder Metallurgy, Inc.

Porosity in metals is often undesirable; sometimes, however, it is produced purposely in metal parts. In either case it is interesting to know how porosity affects the physical properties. Specimens of accurately controlled porosity made by sintering were tested for fatigue strength and compared with solid specimens. Two test series are described: one with copper, the other with iron. The ratios of fatigue strength to tensile strength were determined. Porosity affects the fatigue strength more than could be explained by mere reduction in cross-section. On the other hand, the drop in fatigue strength is less than might be expected, as long as the porosity is not excessive.

**Fatigue Strength of 2-in. Diameter Axles with Surfaces Metal Coated and Flame Hardened.** O. J. Horger and T. V. Buckwalter, The Timken Roller Bearing Co.

Fatigue investigation was made of axles tested as cantilever rotating beams 2 in. in diameter. Axles with and without stress concentration were sprayed with a metal coating. Also axles with stress concentration were locally flame hardened. Fatigue tests were made on these specimens and comparison made with similar axles without surface treatment.

The base axle materials were S.A.E. 1035 and 1045 steels and the sprayed metal was 0.40 and 1.20 per cent carbon wire stock. The nature of the stress concentration was a press-fitted wheel. Test results with plain specimens indicated little difference in endurance limit of coated axles over that for uncoated axles. Press-fitted wheel and axle assemblies showed a great increase in endurance limit of the coated and flame hardened axles over the untreated axles.

**Fatigue Tests on Zinc-Coated Steel Wire.** D. G. Watt, The Hydro-Electric Power Commission of Ontario.

Fatigue tests, performed in Haigh-Robertson machines, were employed to determine which of a number of zinc-coated steel wires, supplied by different manufacturers in various grades, were best suited to resist the repeated bending stresses imposed on transmission line ground-wire cables by aeolian vibrations. Wires of different ultimate strengths were tested in the lead-annealed, hot-dip galvanized, or electrogalvanized conditions. Physical testing was supplemented by microscopic study of the wires and their coatings.

**A Pulsating Tension-Fatigue Machine for Small Diameter Wire.** John N. Kenyon, Columbia University.

A new pulsating tension-fatigue machine is developed by employing three reciprocating forces, 120 deg. out of phase, thus exerting a constant torque on the motor and eliminating unbalanced inertial effects. A gripping method is developed whereby over 80 per cent of the fatigue breaks are in the clear. The machine is especially adapted for testing used wire to determine the loss in endurance properties.

**The Effect of Protective Coatings on the Corrosion-Fatigue Strength of Steel.** Thomas J. Dolan and Hugh H. Benninger, University of Illinois.

To examine the relative efficiency of several commercially used protective coatings in increasing the corrosion-fatigue strength of steels, laboratory tests were made of specimens subjected to completely reversed cycles of flexural stress while in contact with fresh tap water. The chief effect of the electroplated coatings seemed to be a lengthening of the time (and number of cycles of stress) required to cause failure of a specimen in corrosion-fatigue. The nitrided case was very efficient in resisting pitting due to corrosive attack and the corrosion-fatigue endurance limit of the nitrided specimens was the highest obtained (85,000 psi.) from any of the materials tested.

**A Corrosion-Fatigue Test to Determine the Protective Qualities of Metallic Platings.** John N. Kenyon, Columbia University.

Describes a corrosion-fatigue test for determining the extent of protection afforded by metallic platings. Steel bead wire, automobile tire reinforcement, was used for the investigation. It was found that plating with a more noble metal, such as copper, may actually contribute to the embrittlement of steel wire by reason of galvanic action at points of imperfection in the plating. No embrittling condition was encountered where the wire had first been galvanized before plating with copper. The results are valuable in connection with fatigue phenomena and the various factors influencing fatigue failure.

## Thursday, June 27 9.30 a.m. Fourteenth Session

Held Simultaneously with Thirteenth Session

## Symposium on Spectrographic Analysis

The two sessions (morning and afternoon) of the Symposium on Spectrographic Analysis contemplate a frank interchange of views between the engineer or metallurgist who develops and uses metallurgical specifications on the one hand, and the analytical spectrographer who, on the other, checks such metals and alloys for conformance to compositional requirements. The limitations and possibilities of quasi-quantitative, quantitative and "Go - No Go" spectrography are to be explored from two angles. As the spectrograph is here considered as a tool of the analytical chemist much of the discussion presented by the engineer should be fundamental to the entire concept of analytical chemistry although original plans to definitely tie in with the preceding Symposium on Tools of Analytical Chemistry have not been fully feasible.

With two exceptions, the speakers presenting the case for specification requirements as to required approach to accuracy, the basic theme, will be the engineer chairman or vice-chairman of a main A.S.T.M. committee. Selected speakers from Committee E-2 will then reply to the morning topic of "Accuracy Requirements *versus* Reproducibility Possibilities."

The afternoon session will be devoted to pro and con discussion of the Presentation of Results by the spectroscopists with reply as to the Interpretation of Results by the engineer and metallurgist.

The greater accuracy required in ascertaining threshold values of impurities or intentionally added or preserved minor but important increments in terms of maxima and minima is to be stressed in contrast to cases where these amounts may be away from the border line. The process of developing a specification is to be explored as against the routine checking. Factors affecting reproducibility and accuracy, such as varying emission and photographic techniques for example, will illustrate the variables involved.

Summed up, it is proposed to explore the use of certain ambiguous terms employed where indicative qualitative analysis will suffice; to consider whether terms used in the spectroscopic sense necessarily mean the same to the engineer, technologist, or businessman; to what degree accuracy is being confused with reproducibility; finally wherein is the spectrographer failing to meet or exceeding the degree of accuracy required by the engineer during the development or subsequent use of a specification.

**Morning Session—**

**Variables *versus* Constants in Emission Spectrography.** Thomas A. Wright, Lucius Pilkin, Inc.

**Accuracy Requirements *versus* Reproducibility Possibilities:**

W. H. Bassett, Jr., Anaconda Wire and Cable Co.
E. B. Ashcraft, Westinghouse Electric and Manufacturing Co.
H. H. Stout, Jr., Phelps Dodge Copper Products Corp.
Harry A. Bright, National Bureau of Standards.
C. B. Francis, Carnegie-Illinois Steel Corp.
M. L. Fuller, The New Jersey Zinc Co.
G. J. Steele, General Electric Co.
A. E. Ruehle, Bell Telephone Laboratories, Inc.
A. W. Petrey, Aluminum Company of America.
O. S. Duffendack, University of Michigan.
Lester W. Strock, New York State Research Institute.

## Thursday, June 27 2 p.m. Fifteenth Session

Held Simultaneously with Sixteenth Session

## Symposium on Spectrographic Analysis *(Continued)*

**Afternoon Session—Interpretation of Results:**

C. C. Nitchie, Bausch & Lomb Optical Co.
A. C. Downes, National Carbon Co., Inc.
Morris Slavin, U. S. Bureau of Mines
A. W. Kenney, E. I. du Pont de Nemours and Co., Inc.
W. R. Koch, Air Corps, U. S. A.
A. J. Phillips, American Smelting and Refining Co.
T. S. Fuller, General Electric Co.
J. R. Townsend, Bell Telephone Laboratories, Inc.
Sam Tour, Lucius Pitkin, Inc.
W. H. Finkeldey, Singmaster & Breyer.
E. E. Thum, American Society for Metals.

## Thursday, June 27 2 p.m. Sixteenth Session

Held Simultaneously with Fifteenth Session

## Effect of Temperature, Creep

**Report of Joint Research Committee on Effect of Temperature on the Properties of Metals.** N. L. Mochel, Chairman.

A brief summary of the progress made during the year in the various research projects sponsored by the joint committee. These include tests of tubular members at elevated temperatures, properties of metals at low temperatures, relation of torsion-creep and tension-creep, relaxation tests, and study of a high-temperature life test method.

Included in an appendix is a report on the effects of manufacturing variables on the high-temperature properties of metals; also a list of published reports on tests of 0.35 per cent carbon steel K20 with brief abstracts of each article listed.

**High-Speed Tension Tests at Elevated Temperatures.** M. Manjoine and A. Nadai, Westinghouse Electric and Manufacturing Co.

Practically little is known about the actual forces required to deform steel or some of the other ductile metals at high velocities of strain and at elevated temperatures. A high-speed tension machine was developed in which tension tests could be made with small samples. The test specimens occupied the axis of a copper coil which acted as an induction furnace, in which temperatures up to 1200 C. could be reached. The tension tests were carried out at an approximately constant relative velocity between the heads. Stress-strain curves were automatically recorded on the screen of a cathode-ray oscillograph using the elastic strain in a very rigid tension specimen as means for the indication of the load and the movement of one of the heads of the specimens for determining the strains.

**The Creep of 17 Low Alloy Steels at 1000 F.** R. F. Miller, W. G. Benz, United States Steel Corp., and W. E. Unverzagt, National Tube Co.

The steels included in the paper are divided into three groups: (1) 0.13 to 0.21 per cent carbon-molybdenum steels, with molybdenum varying from 0.5 to 2.0 per cent; (2) 1.25 to 3.26 per cent chromium-molybdenum steels with varying chromium, molybdenum, silicon, and aluminum content; and (3) 4.96 to 5.66 per cent chromium-molybdenum steels, with varying chromium, molybdenum, silicon, aluminum, titanium, and columbium content.

Data are included on effect of heat treatment on creep strength, structural stability, and change of hardness and impact strength during the creep tests.

**Some Effects of Composition and Heat Treatment on the High Temperature Rupture Properties of Ferrous Alloys.** R. H. Thielemann, General Electric Co.

The susceptibility of certain ferrous alloys to failure by brittle intergranular cracking at elevated temperature has been demonstrated by both operating experience and by laboratory tests. With the occurrence of this phenomenon, the normal amount of deformation preceding fracture may be greatly reduced, and there is usually no noticeable indication of the impending failure. The results described indicate that in the 900 F. to 1300 F. range the susceptibility to failure varies with the alloy compositions. A system by which a chromium equivalent composition value of an alloy car be calculated is found to be useful. The effect of increased grain size and of microstructure resulting from heat treatment on the high-temperature rupture properties are discussed.

**Creep Recovery at Elevated Temperatures.** P. G. McVetty, Westinghouse Electric and Manufacturing Co.

Test data on various materials at three temperatures indicate that a part of the plastic deformation known as "creep" is not permanent. Evidence is advanced to support a hypothesis that the removal of stress at the end of a creep test leaves an internal stress with a component approximately equal to the applied stress, but in the opposite direction. The observed phenomena of creep recovery are explained as results of the relaxation of this stress. The effects of this concept upon the application of creep data to intermittent operation at high temperatures are discussed, and a tentative method of evaluation proposed.

**High Temperature Rupture and Creep Tests.** Ernest L. Robinson, General Electric Co.

The comparison of long-time rupture tests with creep tests on alloy steels at high temperature gives information of importance to designers of machinery. Higher stresses are used in rupture tests than in creep tests and give high rates of creep. However, the lower loadings that give longer life result in rupture with less total elongation. Extrapolation of results indicates that rupture after 100,000 hr. may sometimes be accompanied by elongations as small as one per cent or even less. Furthermore, materials having relatively high creep strength may have scant margins of safety; whereas low creep strength materials used with low design stresses may have but slightly reduced rupture strength and thus greater margins of safety.

## Thursday, June 27 8 p.m. Seventeenth Session

Held Simultaneously with Eighteenth Session

## Petroleum Products, Bituminous Materials, Road Materials, Soils

**Report of Committee D-2 on Petroleum Products and Lubricants.** T. A. Boyd, Chairman.

A procedure for calculating viscosity index is presented as well as new methods of test for dropping point of lubricating greases, and for carbonizable substances in white mineral oil (liquid petrolatum). A new proposed method of test for aniline point of petroleum products and a revision of the Diesel-fuel-oil classification and the test for ignition quality of Diesel fuels are included as information. The report also recommends for immediate adoption revisions in six standard methods which cover two distillation tests of gasoline, Pensky-Martens flash point test, knock characteristics of motor fuels, water test, and methods of analysis of grease. The specifications for Stoddard solvent, and the test for sulfonated residue of plant spray oils are recommended for adoption as standard. Revisions are submitted in four tentative methods. A revised procedure for neutralization number is also presented as tentative.

**Report of Sectional Committee Z11 on Petroleum Products and Lubricants.** T. A. Boyd, Chairman.

Reports on standards being recommended for submission to American Standards Association for approval as American standard.

**Report of Committee D-4 on Road and Paving Materials.** E. F. Kelley, Chairman.

Submits as tentative new specifications for materials suitable for stabilized base course and for stabilized surface course in road construction. Proposed specifications and methods of test for preformed expansion joint fillers of the bituminous type for concrete are included as information. The report also contains the results of a comparative study of the loss on heating test, in which several types of ovens were used.

**Report of Committee D-8 on Bituminous Waterproofing and Roofing Materials.** J. M. Weiss, Chairman.

The adoption as standard of the two tentative methods of test for sieve analysis of mineral surfacing materials for asphalt roofing and shingles is recommended; also a revision of the specifications for woven cotton fabrics saturated with bituminous substances for use in waterproofing. The committee reports that consideration is being given to important revisions in a number of specifications and methods of test for which it is responsible and recommends that these be continued in their present status until such work is completed.

**A Study of the Recovery of the Bitumen from Soft Asphalt Cements by the Bussow Method.** Carl Bussow, A. W. Dow, Inc.

The author's method is described and data are presented on the recovery of nine asphalts from different sources, ranging from 50 to 270 in penetration, and showing the influence of the maximum temperature of recovery on the penetration and loss on heating of the recovered asphalts. Precautions necessary in the extraction and recovery of asphalts by either the author's method or the Abson method are discussed. An explanation is offered for the loss in ductility in asphalts recovered by the Abson method.

**The Measurement of the Deformation Properties of Asphalts.** T. F. Ford and K. G. Arabian, Shell Development Co.

The empirical methods now in use in the asphalt industry for characterizing asphalts according to their deformation behavior are generally agreed to be inadequate. Of various new methods which have been proposed those employing the principle of the Couette viscosimeter are soundest from the theoretical standpoint. A simple viscosimeter of this type is here described. The instrument requires small samples, permits rapid measurements, and gives results which are equal in accuracy to those obtained in more complicated instruments. The measurements made permit calculation of fundamental deformation constants.

**The Mechanics of Granular and Granular-Plastic Materials, with Especial Reference to Bituminous Road Materials.** V. A. Endersby, Shell Development Co.

In triaxial testing, the Mohr envelope is found curved in a manner not consistent with the conceptions of pure frictional and linear-plastic cohesive resistance. A method is developed for analyzing the different forms of resistance in the specimen, with examples, and application to variable pavement thicknesses. It is shown that whole mixes rather than fractions should be tested, and that dimensional relations in practical applications must be considered. The bituminous binder is shown to have a more complex effect upon mechanical stability than has been generally recognized.

**Rheological Interpretation of Asphalt Tests.** R. N. Traxler, H. E. Schweyer, and J. W. Romberg, The Texas Company.

The uses for asphalts are generally governed by their flow properties under application or service conditions. It is pointed out that evaluation of these properties in absolute units would be more satisfactory than the use of the numerous empirical tests now employed.

The types of flow encountered in asphalts are illustrated by rheological diagrams, and terms employed in the rheology of asphalt are defined. A brief review is given concerning the colloidal nature of asphalt as related to its flow properties; methods employed and problems encountered in the investigation of the flow properties of such materials are discussed.

**Report of Committee D-18 on Soils for Engineering Purposes.** H. F. Clemmer, Chairman.

Four new tentative methods have been perfected for testing soil-cement mixtures, comprising procedures for determining moisture-density relations, for moisture and volume changes produced by repeated wetting and drying, and by freezing and thawing of compacted specimens; also test for water absorption and resistance to plastic flow of mixtures of soil and emulsified asphalt. A list of recommended definitions and symbols pertaining to soils is presented, and revisions in the tentative methods of surveying and sampling soils for highway subgrades are recommended.

## Thursday, June 27 8 p.m. Eighteenth Session

Held Simultaneously with Seventeenth Session

## Concrete *(Continued from Twelfth Session)*

## Sanford E. Thompson Award

**Report of Committee C-9 on Concrete and Concrete Aggregates.** F. H. Jackson, Chairman.

A new tentative laboratory method for determining the efficiency of materials for curing concrete has been completed and also a new method of test for volume change of cement mortar and concrete. The latter is intended to provide a standardized method for making comparative tests when a simple routine procedure is desired. A revision of the requirements for curing specimens as provided in the standard method of test for compressive strength of concrete is recommended as tentative.

**Sanford E. Thompson Award.**

To T. F. Willis and M. E. De Reus, Research Engineer, and Junior Engineer, respectively, Bureau of Materials, Missouri State Highway Dept.

The First Sanford E. Thompson Award will be made to T. F. Willis and M. E. De Reus, Research Engineer, and Junior Engineer, respectively, Bureau of Materials, Missouri State Highway Dept., for their paper on "Thermal Volume Change and Elasticity of Aggregates and Their Effect on Concrete," presented before the Society at the 1939 Annual Meeting. The Sanford E. Thompson Award was established in 1938 by Committee C-9 on Concrete and Concrete Aggregates as an annual token of recognition to the author or authors of a paper of outstanding merit on concrete and concrete aggregates presented at an annual meeting of the Society. The award is named in honor of the first chairman of the committee.

**The Soundness of Chert as Measured by Apparent Specific Gravity and Absorption.** Charles E. Wuerpel and E. P. Rexford, U. S. Military Academy.

The relationship which exists between the pore structure, absorptive capacity, apparent specific gravity, and the soundness of cherts in glacial and alluvial gravels of the eastern portion of the United States is demonstrated. The criteria of soundness used are the magnesium sulfate soundness test and freezing-and-thawing tests of concrete specimens. The existence of the relationship permits the use of a simple flotation procedure as an aid to the quantitative estimation of the presence of unsound cherts in gravel deposits. The physical test data are supported by microscopic studies of the mineral and pore structures of the cherts investigated.

**The Absorption and Freezing-and-Thawing Tests of Coarse Aggregate.** F. V. Reagel, Missouri State Highway Dept.

The effects of various preliminary treatments on the total absorption and on the ultimate deterioration of the material in freezing and thawing.

**Report of Committee C-13 on Concrete Pipe.** Theodore Doll, Chairman.

Presents revisions in the four standards for which this committee is responsible covering, respectively, concrete sewer pipe, irrigation pipe, reinforced-concrete sewer pipe, and reinforced-concrete culvert pipe.

**The Significance of the Flexure Test in Designing Concrete Mixtures for Pavements.** W. F. Kellermann, Federal Works Agency, Public Roads Administration.

Presents results of tests to determine the concrete-making properties of concrete aggregates as measured by the flexure test. Because pavements are continually being flexed, the tensile or flexural strength is a critical factor. Aggregates of varying mineral composition were tested in concrete to determine the resulting cement factor required to produce a minimum flexural strength. All tests were made in accordance with A.S.T.M. Standard Method of Test for Flexural Strength of Concrete (C 78 – 39). The results indicate that when designing concrete mixtures for pavements the particular aggregate to be used must be investigated in order economically to produce concrete of the desired properties.

**Effect of Difference in Dimensions and in Methods of Loading upon the Strength Characteristics of Flexure Specimens.** John Tucker, Jr., National Bureau of Standards.

There is an inherent variation in the strength of duplicate test specimens no matter how carefully these specimens are tested. Such variations are a natural characteristic of the materials and are more pronounced in some materials than in the others. The paper shows how the variations in unit strength of a material will affect the modulus of rupture in tests of beams of different dimensions and beams subjected to different loading. For example, the modulus of rupture of a beam will be decreased with beam length and will be greater in centrally loaded beams than in similar beams loaded at third points.

**Measuring Changes in Physical Properties of Concrete Materials by the Dynamic Method.** William T. Thomson, Kansas State College of Agriculture and Applied Mechanics.

The two important dynamic properties of any elastic system are the natural frequency of vibration and the rate of damping or the decrement. In the case of a vibrating beam of a given dimension, the former is related mainly to the ratio of the modulus of elasticity to the mass density, while the latter is related to the energy dissipated by internal and external friction. This paper is chiefly concerned with the changes produced in these physical properties by the deterioration of concrete. The changes in the natural frequency and the decrement due to the deterioration of the specimen are revealed by the dynamic method of testing. Included are also some precautionary measures that must be observed in interpreting data taken by apparatus of the type used.

## Friday, June 28 9.30 a.m. Nineteenth Session

Held Simultaneously with Twentieth Session

## Textiles, Soaps, Paint, Timber, Paper, Fuels

**Report of Committee D-13 on Textile Materials.** H. J. Ball, Chairman.

The first proposed standards covering glass textiles are included in this report. These include methods of testing and tolerances for glass yarns, woven glass tape, glass fabrics, and tubular glass sleeving and braids. Two new important methods included cover procedures for determining resistance of fabrics to water and test for resistance of fabrics to moths. New tentative specifications are recommended for household blanketing (wool, cotton, and cotton-wool fabrics) and methods of testing woven asbestos cloth; also a procedure for determining shrinkage of raw wool (laboratory-scale operations).

The tentative specifications for terry toweling, methods of testing wool felt and rayon yarns, test for fiber length of wool, and definitions of terms are recommended for adoption as standard. Several important tentative revisions in the three standards for asbestos textiles are also included. A proposed recommended practice for calculating the number of tests to be specified in determining the average characteristic of a textile material has been completed.

**The Creep Phenomenon in Ropes and Cords.** Carlton G. Lutts and David Himmelfarb, U. S. Navy Yard.

Ropes and cords under tension undergo continual elongation, corresponding to the creep phenomena in metals. Where the tension is maintained for a sufficiently long period, the rope actually breaks. Ropes were loaded with various tensions ranging from 41 to 89 per cent of their normal breaking strength, and in time these ropes broke. The periods of time the tensions were sustained varied from several minutes at the maximum tension to several hundred hours at the minimum. The stretch of the ropes during their periods of tension was also measured.

**Report of Committee D-12 on Soaps and Other Detergents.** H. P. Trevithick, Chairman.

Three proposed new specifications cover olive oil solid soap, palm oil solid soap, and salt-water soap; also specifications for sodium sesquisilicate and tetrasodium pyrophosphate (anhydrous). Proposed specifications for detergent soap powder and grit cake soap are also included in the report as information. The committee is presenting several new definitions relating to soaps and other detergents and revisions in the existing definitions. Revisions are presented in the tentative specifications for palm oil bar soap. New methods of sampling and analysis of sodium sesquisilicate are presented as tentative and a revision of the titer test in the standard methods of analysis of soaps is included.

**Report of Committee D-17 on Naval Stores.** F. P. Veitch, Chairman.

This progress report discusses briefly the considerations being given by the committee to further studies of softening point of certain resins and rosins, the crystallizing tendency of rosins, procedures for determining acid number and saponification value, and a test for unsaponifiable matter.

**Report of Committee D-1 on Paint, Varnish, Lacquer, and Related Products.** H. E. Smith, Chairman.

Among the recommendations are new tentative specifications for carbon black and methods of test for liquid dryers, consistency test of enamel type paints, determination of phthalic anhydride content of alkyd resin solutions. The committee is also presenting for immediate adoption revisions in 15 standard specifications for various types of pigments. Tentative revisions in the methods of chemical analysis of white linseed oil paints and in the methods of sampling and testing turpentine are submitted. The specifications and methods of chemical analysis of zinc dust submitted as tentative last year are recommended for adoption as standard, together with the test for reactivity of paint liquids. Tentative revisions in seven standards are recommended for adoption.

**The Evaluation of Titanium Pigments for Use in the Paint Industry.** W. B. Anderson, Titanium Pigment Corp.

Determination by standard methods of the commonly recognized properties of titanium pigments is not sufficient to indicate broadly their effects in actual use. As a result utility tests have been employed to indicate the significant effects of these pigments on the manufacture and properties of finishes. Such methods for determining the effects of the pigments upon mixing and grinding with vehicles and film characteristics are discussed briefly. The methods are for the most part comparative and depend upon the use of standard samples of pigments and standardized vehicles.

**An Extraction Method for the Determination of Metals in Boiled Linseed Oil and Driers.** Frank Gottsch and Benjamin Grodman, Central Testing Laboratories.

Describes a new procedure for determining lead in boiled linseed oil, and indicates the necessary modifications for determining lead, zinc, cobalt, and manganese in driers. Discusses difficulties in the ash method as described in Federal Specifications JJJ-O-331, and includes an exposition of the chemical principles involved in the new method.

**Report of Committee D-7 on Timber.** Hermann von Schrenk, Chairman.

This progress report presents an important editorial change in the test for tar acids in creosote and creosote-coal tar solutions, and mentions briefly the consideration being given by the subcommittee on nomenclature and definitions to the commercial names of several species of American woods.

**Report of Committee D-6 on Paper and Paper Products.** R. C. Griffin, Chairman.

Important proposals include the publication as tentative of seven new methods covering procedures for sampling paper and tests for estimating the ash content and measuring the opacity of paper and paper products; also procedures for the following constituents: qualitative test for casein content, determination of alpha, beta, and gamma cellulose, qualitative and quantitative test for starch in paper, and a quantitative test for paraffin content of waxed papers.

A comprehensive research program resulting in the obtaining of authoritative and extensive data on the physical properties of container grades of paper board and of paper board containers is reported upon.

**Report of Committee D-3 on Gaseous Fuels.** A. C. Fieldner, Chairman.

This progress report includes a résumé of activities of the seven subcommittees on collection and on measurement of gaseous samples, on calorific values of gaseous fuels, on specific gravity and density, on determination of impurities of gaseous fuels, on water vapor content, and on analysis of gaseous fuels.

**Report of Committee D-5 on Coal and Coke.** A. C. Fieldner, Chairman.

An extensive revision of the tentative method of sampling coals according to ash content has been developed. The pending tentative revision of the standard method of sampling coal for analysis and of the general methods of laboratory sampling and analysis which embrace provisions for the mechanical preparation of the sample are recommended for adoption as standard. A revised definition of the term "coke" is also submitted for adoption as standard.

The report discusses the considerations being given by the committee to a revision of the test for fusibility of ash, experimental work on methods of determining the ash of coals containing pyrite and calcite, on plasticity and swelling of coal, and experimental study on the ignitibility of coal and coke to serve as the basis for a new tentative method.

## Friday, June 28 9.30 a.m. Twentieth Session

Held Simultaneously with Nineteenth Session

# Non-Ferrous Metals

**Report of Committee B-5 on Copper and Copper Alloys, Cast and Wrought.** C. H. Greenall, Chairman.

Materials covered by seven new specifications include cartridge case cups, gilding metal sheet and strip, bullet jacket cups, copper rods and bars, brass wire, miscellaneous brass tubing, and leaded high-strength yellow brass (manganese bronze) castings. A number of improvements are presented in six specifications covering bronze castings for bridges, brass and copper-silicon sheet and strip, copper alloy condenser tubes, brass pipe, and the classification of cast copper-base alloys. Two tentative specifications are recommended for adoption as standard and revisions for immediate adoption in five standards are presented.

Cooperative work is being carried on by the committee with various governmental bureaus, such as the War Dept., Federal Specifications Bureau, Navy Dept., Bureau of Aeronautics, and other agencies in an effort to correlate the requirements of A.S.T.M. standards and the corresponding governmental specifications. Several of the new specifications for sheet and strip are the result of cooperative work with the War Dept.

**Proportional Limit Tests on Copper Alloys.** Cyril Stanley Smith, American Brass Co.

Methods of obtaining axial loading and precise strain measurement on a 0.5-in. diameter standard tension specimen are described. The stress corresponding to a deviation from proportionality (offset) of 0.000002 in. per inch can be readily determined. Stress-strain curves are reproduced to show the behavior of 70–30 brass after various straining and annealing treatments. The "proportional limit" is lowered very considerably by small amounts of plastic overstrain but is restored by suitable annealing. The deviation from proportionality in cold-worked materials is many times greater than the permanent set resulting from the same load.

**Report of Committee B-2 on Non-Ferrous Metals and Alloys.** E. E. Thum, Chairman.

Revised specifications for pig lead are offered, intended to replace the existing standard specifications. The activities of the several subcommittees on precious metals and on refined non-ferrous, and miscellaneous non-ferrous metals and alloys are briefly discussed.

**Internal Hydraulic Bursting Tests of Lead Cable Sheathing.** Howard S. Phelps, Albert M. Gates, and Frank Kahn, Philadelphia Electric Co.

One of the most vulnerable components of lead sheathed power cable appears to be the lead sheath itself. This paper describes a method for making reproducible hydrostatic bursting tests of cylindrical lead specimens, which has been developed to simulate service conditions. Reliable test data are now being obtained from which it is hoped to determine the kind of lead or lead alloy which will best withstand internal pressures developed in service. Results to date have revealed information about lead sheathing that gives a new conception of the problem. Suggestions are made for further study.

**Bursting Tests and Tension Tests for Lead Cable Sheathing.** H. F. Moore, C. W. Dollins, and W. J. Craig, University of Illinois.

In cooperation with the Philadelphia Electric Co. comparative tests to fracture under long-time steady load were made (1) by subjecting full sections of lead cable sheathing to internal oil pressure, and (2) by testing tension specimens cut with axis in a circumferential direction from pieces of the same sheathing. Four sets of tests were made, and there was found a good agreement between the nominal stress developed in the bursting tests and the tensile strength developed in the tension tests. There was also a quite good agreement between the increase of diameter in the bursting tests and the elongation of the tension specimens.

**The Testing of Lead Cable Coverings.** W. H. Bassett, Jr., and C. J. Snyder, Anaconda Wire and Cable Co.

A new theory is suggested regarding the life of various extruded lead and lead alloy cable sheaths subjected to constant or intermittent tensile stress. The results indicate that at some low stress, such as 400 psi., all types of lead and lead alloys, regardless of their tensile strength as normally expressed, will fail in approximately the same period of time.

By making four bursting tests at different pressures the investigator can classify a given sample of lead sheath with respect to the softest lead or the hardest age-hardening alloy used by the power cable industry and can estimate its usefulness with the possible exception of resistance to corrosion and fatigue.

## Friday, June 28 2 p.m. Twenty-first Session

Held Simultaneously with Twenty-second Session

# Non-Ferrous Metals *(Continued)*

**Report of Committee B-6 on Die-Cast Metals and Alloys.** J. R. Townsend, Chairman.

This report recommends a revision in alloy No. XXV of the tentative specifications for zinc-base alloy die castings based on test data obtained during the year. Work on the preparation of specifications covering plated coatings for zinc-base die castings are briefly discussed.

The report includes detailed test data on the aluminum die-casting alloys of high purity which have been removed from exposure test racks after 5 yr. Results of the corrosion tests after 10 years' atmospheric exposure of the zinc-base alloy test bars are appended to this report. The commercial status of these alloys at the present time is also discussed and the report states that new tests are being undertaken on present-day commercial zinc alloys.

**Report of Committee B-7 on Light Metals and Alloys, Cast and Wrought.** Sam Tour, Chairman.

New methods of test for weight of coating on anodically coated aluminum and for sealing of anodically coated aluminum are submitted. Revisions are also presented in five specifications for magnesium base alloy ingots, castings, sheet, rods, and shapes.

**Papers Appended:**

Anodic Coatings Seen Through the Microscope. F. Keller, Aluminum Company of America.

The microscope has been found very useful for studying the features responsible for differences in properties and appearance of the oxide coatings on anodically treated aluminum alloys. This paper describes the various metallographic methods which have been developed for the investigation of anodic oxide coatings and illustrates the results obtained by the use of these methods.

Thickness of Anodic Coatings on Aluminum. Junius D. Edwards, Aluminum Company of America.

The thickness of an oxide coating is a characteristic which may help determine its usefulness for a variety of purposes. The measurement of coating thickness therefore becomes a matter of commercial importance. This paper presents some of the methods which may be employed for measuring the thickness of the types of anodic coatings now being used for decorative and protective purposes. These range from about 0.0001 to 0.0006 in. in thickness. The paper also gives information regarding the accuracy and field of application of these methods.

The Abrasion Resistance of Anodically Oxidized Coatings on Aluminum. H. G. Arlt, Bell Telephone Laboratories, Inc.

An abrasive air-blast method for measuring the resistance to abrasion of anodically oxidized coatings on aluminum is described. Abrasion values of a high order of precision are obtainable which permit establishing the relationship of abrasion resistance to thickness, oxidizing time, current density, base alloy, etc. Preliminary data from several laboratories indicate the possibilities of using the method for inspection purposes.

Electrical Breakdown of Anodically Oxidized Coatings on Aluminum: A Means of Checking Thickness of Anodized Finishes. K. G. Compton and A. Mendizza, Bell Telephone Laboratories, Inc.

A rapid method of determining the thickness of aluminum oxide coatings without undue destruction of the work consists in measuring the voltage breakdown of the coating. Data are given which show the relationship between breakdown resistance, anodizing time, thickness of coating, current density, and sealing of anodically oxidized polished commercially pure aluminum. Statistical data for the values obtained are also given, indicating the good reproducibility of the breakdown values. Although only one of the many anodizing possibilities has been investigated, the applicability of this method of evaluating the thickness of oxide coatings may be extended to all commercial treatments.

**Report of Committee B-1 on Copper and Copper-Alloy Wires for Electrical Conductors.** J. H. Foote, Chairman.

Recommends the adoption as standard of the tentative specifications for figure-9 deep-section grooved and figure-8 copper trolley wire for industrial haulage. Revisions are also presented in the tentative specifications for soft rectangular and square copper wire for electrical conductors, which changes provide for a reduction in the size of recommended packages of very small sizes of wire, a clarification of prescribed shapes and tolerances for wire having half-rounded edges, and a modification of the method for selecting samples and of the requirements for retests. Reference is made to new specifications for cable other than concentric construction which are now in preparation.

**Report of Committee B-4 on Electrical-Heating, Electrical-Resistance and Electric-Furnace Alloys.** Dean Harvey, Chairman.

In addition to new tentative methods of testing sleeves and tubing for radio tube cathodes, the report also recommends the adoption as standard of the Tentative Method of Test for Bend Testing of Wire for Radio Tubes and Incandescent Lamps and the Test for Flexivity of Thermostat Metals, with revisions in the latter.

The work being carried on by the committee in a study of the life test for materials for electric furnace resistors on the effect of ceramics and cements upon the life of heating elements in contact with them is discussed. A program of work on the study of methods of test for electrical contact metals is being initiated. Considerable work is under way on tests for stiffness, brittleness, and of the tensile strength of tungsten wire; also a high-temperature test for filament material for radio tubes. Cooperative life studies by four laboratories are being conducted on the effect of atmosphere on furnace resistors.

**Creep of Aluminum Subjected to Bending at Normal Temperatures.** Joseph Marin and L. E. Zwissler, Armour Institute of Technology.

This investigation deals with an experimental study of an aluminum alloy subjected to pure bending accompanied by creep. Creep deflections were measured for various values of constant bending moments. To interpret these results tension creep tests were also made for various stress values. With the experimental constants obtained from the tension creed tests, a creep rate-stress relation is established for tension. Using this relation as a basis, a theoretical differential equation is determined for creep deflections in beams. In this way it is possible to make a comparison between the experimental and theoretical values and thus interpret the tests on creep deflections in bending.

**Miscellaneous Business.**

## Friday, June 28 2 p.m. Twenty-second Session

Held Simultaneously with Twenty-first Session

# Plastics, Electrical Insulating Materials, Rubber

**Report of Committee D-20 on Plastics.** W. E. Emley, Chairman.

Presents as tentative three new methods of test which provide procedures for flow temperatures of thermal plastics, the water absorption of plastics, and a flammability test. The report discusses briefly the considerations being given by the committee to studies of other tests for strength properties of plastics, including tests for compression, tensile and impact strength; hardness properties, such as scratch, wear, and abrasion; also optical characteristics such as haze, reflection factor, polymerization, surface irregularities and brightness; and tests for permanence properties including resistance to heat, light, and water.

**Accelerated Weathering of Transparent Plastics.** G. M. Kline, W. A. Crouse and B. M. Axilrod, National Bureau of Standards.

The effects of different laboratory accelerated aging conditions upon various types of transparent plastics are evaluated on the basis of measurements of light transmission and haze, and visual examination. These results are compared with data obtained for specimens of the same plastics exposed to the weather in Washington. On the basis of these tests a method of accelerated aging of transparent plastics has been developed which gives results correlating well with actual behavior of the materials in outdoor exposure tests. This makes possible the rapid determination of the weathering properties of new plastics and of plastics of modified compositions.

**The Absorption of Water by Plastics.** G. M. Kline, A. R. Martin and W. A. Crouse, National Bureau of Standards.

Experimental data on the absorption and desorption of water by plastics for prolonged periods up to about 600 days and the accompanying dimensional changes are summarized in this paper. These data pertain to the effects of various conditioning procedures, times of immersion, and prior history of the specimens on the values observed for water absorption by plastics. The plastics examined included phenol-formaldehyde molded, cast, and laminated materials, urea-formaldehyde molded and laminated materials, casein, cellulose nitrate, cellulose acetate, ethylcellulose, polyvinyl chloride-acetate, polyvinyl acetal, polystyrene in molded and cast forms, polymethyl methacrylate, and cold-molded plastics of the regular and phenolic types.

**Measuring the Plasticity of Molding Compounds.** Robert Burns, Bell Telephone Laboratories, Inc.

The need for a relatively simple device for measuring the plasticity of molding compounds has been recognized for some time. For those consumers of plastics who require some means of controlling the moldability of their compounds in mutually understandable terms, a device is described which constitutes a simple and inexpensive supplement to the more precise methods. Data are given on a variety of compounds, both thermosetting and thermoplastics, and the effects on plasticity of such variables as moisture content of the powder, temperature, and pressure are discussed.

**Report of Committee D-9 on Electrical Insulating Materials.** T. Smith Taylor, Chairman.

The tentative methods of testing insulating paper, specifications and tests for flexible varnished tubing and specifications for phenolic laminated sheet for radio applications are to be revised. The tentative revision of the test methods for electrical insulating oils referring to the color test to be used is recommended for adoption as standard. New tentative revisions are presented in the standard methods of testing electrical insulating oils and molded materials, and in the tests for sheet and plate materials, laminated tubes, and laminated round rods. Methods recommended for adoption as standard cover tests for conducting paths in slate, for arc resistance, and for shellac used in electrical insulation.

**A Correlation of the Chemical and Electrical Changes Observed During the Oxidation of Mineral Insulating Oil.** F. M. Clark, General Electric Co.

Analyzes the general relations existing between the various chemical and electrical properties of mineral transformer oil as affected by oxidation and describes the difficulty of setting up limiting test values.

Of the tests of practical utility the color and acidity are of importance but demand frequent reference to a laboratory test for potential sludge formation as a criterion of quality. The dielectric strength of the oil is best controlled by its own specific test result. The power factor of the oil is distinct in its behavior from the dielectric strength and is worthy of consideration in proportion to the importance of dielectric loss in the successful operation of the transformer.

**Report of Sectional Committee C59 on Electrical Insulating Materials.** H. L. Curtis, Chairman.

Reports on standards being recommended for submittal to American Standards Association for approval as American standard.

**Report of Committee D-11 on Rubber Products.** O. M. Hayden, Chairman.

The report includes the first standards developed by this technical committee covering procedures for testing automotive hydraulic brake hose and for compression-deflection rate characteristics of vulcanized rubber. The completion of specifications for hydraulic brake hose and for first grade motor mounting compounds classified by physical properties is reported. New tentative methods of test for dynamic compression flexing (compression hysteresis and heat build-up) of vulcanized rubber are also given together with changes in the existing tentative method for compression set of vulcanized rubber.

There are new tentative specifications for ozone-resistant type of wire insulation and revisions are recommended in the companion specifications covering three other types of rubber insulated wire and cable. Revisions are presented in the methods of testing rubber hose and the methods of testing flat rubber belting are revised to include a kerosine-benzol swelling test applicable particularly to oil-resistant belting.

**The Standardization of Durometers.** Lewis Larrick, The B. F. Goodrich Co.

Application of the basic principles of hardness testing to portable testers is given, including a generalization covering all hardness testers used in the rubber industry. Advantages and deficiencies of hand durometers are discussed. Reasons are given why it is impossible for different instruments of a given manufacturer to give identical hardness values, although they can be adjusted to give approximately the same values by careful standardization and control. The technique used at the B. F. Goodrich Co. for Type A Shore Durometers is presented.

**Miscellaneous Business.**